

Stratigraphy of the Upper Martian North Polar Layered Deposits from Radar, Visible And Topographic Data

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Introduction

Objective:

- To precisely tie reflective (and non-reflective) horizons in radargrams to their corresponding layers exposed in outcrop in image data.

To address larger goals:

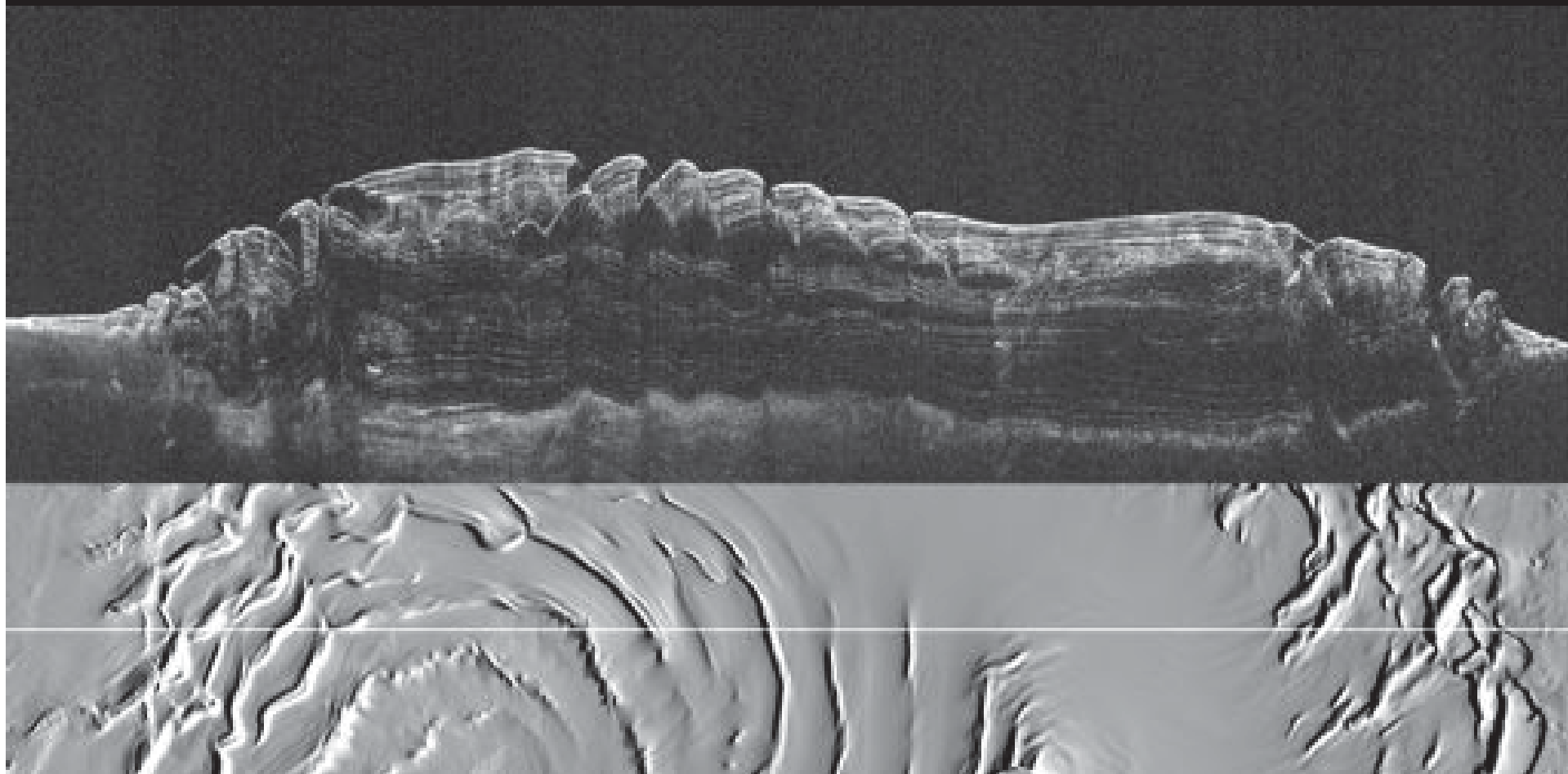
- 1. What is the mechanism causing reflections in the radargrams?
- 2. What stratigraphic (and hence sedimentological/climatic) information is contained in the layers' configuration?
- Can applying the result of Goal 1 inform Goal 2?

Preview of Results

- The upper ~400 m of the NPLD are a continuous stack, representing the last major episode of deposition.
- The upper, middle and lower sections of this stack are marked by distinctive layers, in radar and image data.
- The NPLD section below this stack is riddled with unconformities, marking a previous epoch dominated by erosion.

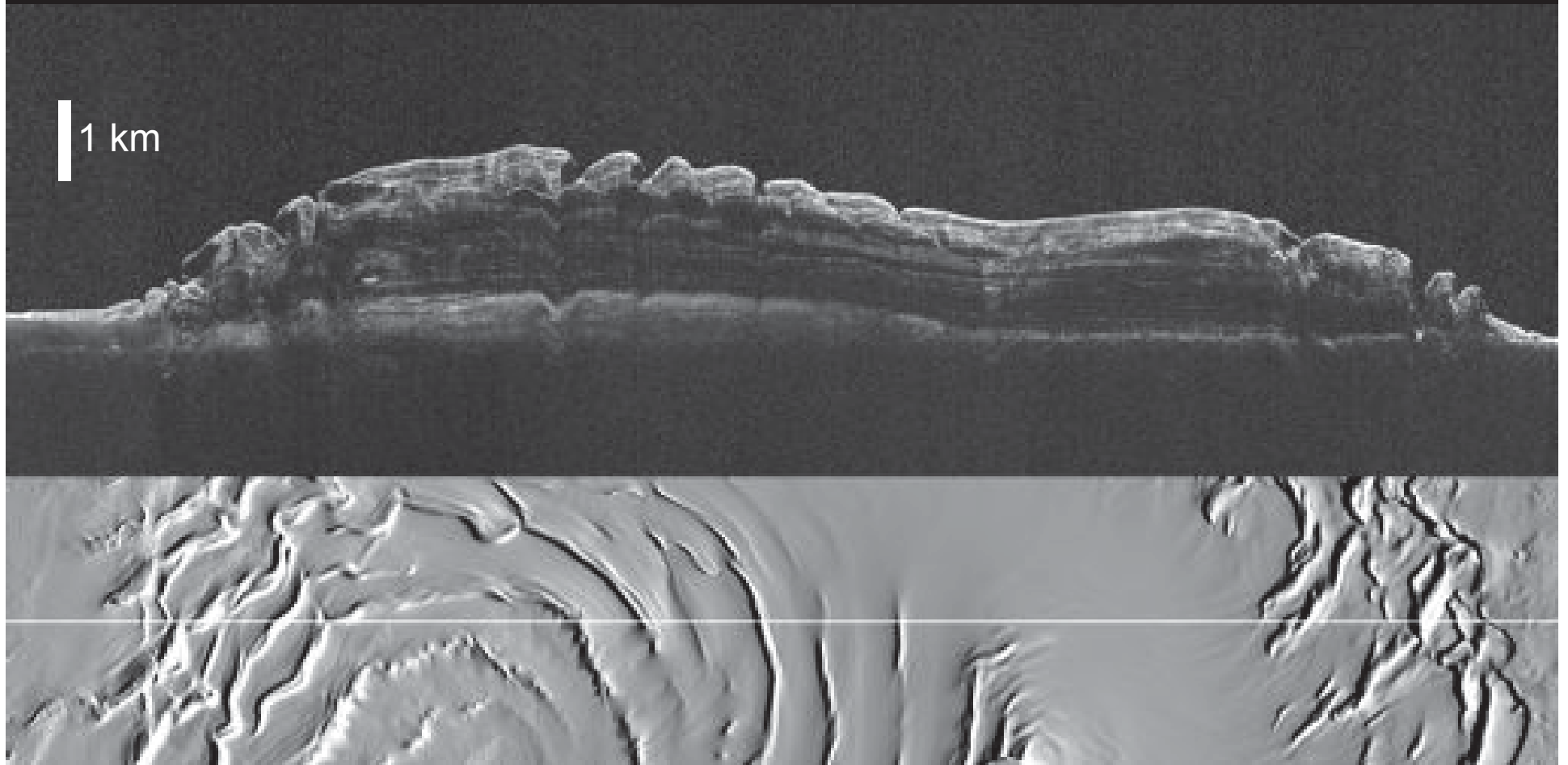
[Note: recent history is erosional; otherwise we wouldn't see exposed layers. After the next depositional episode there will be many unconformities]

SHARAD 5192 – Time Delay



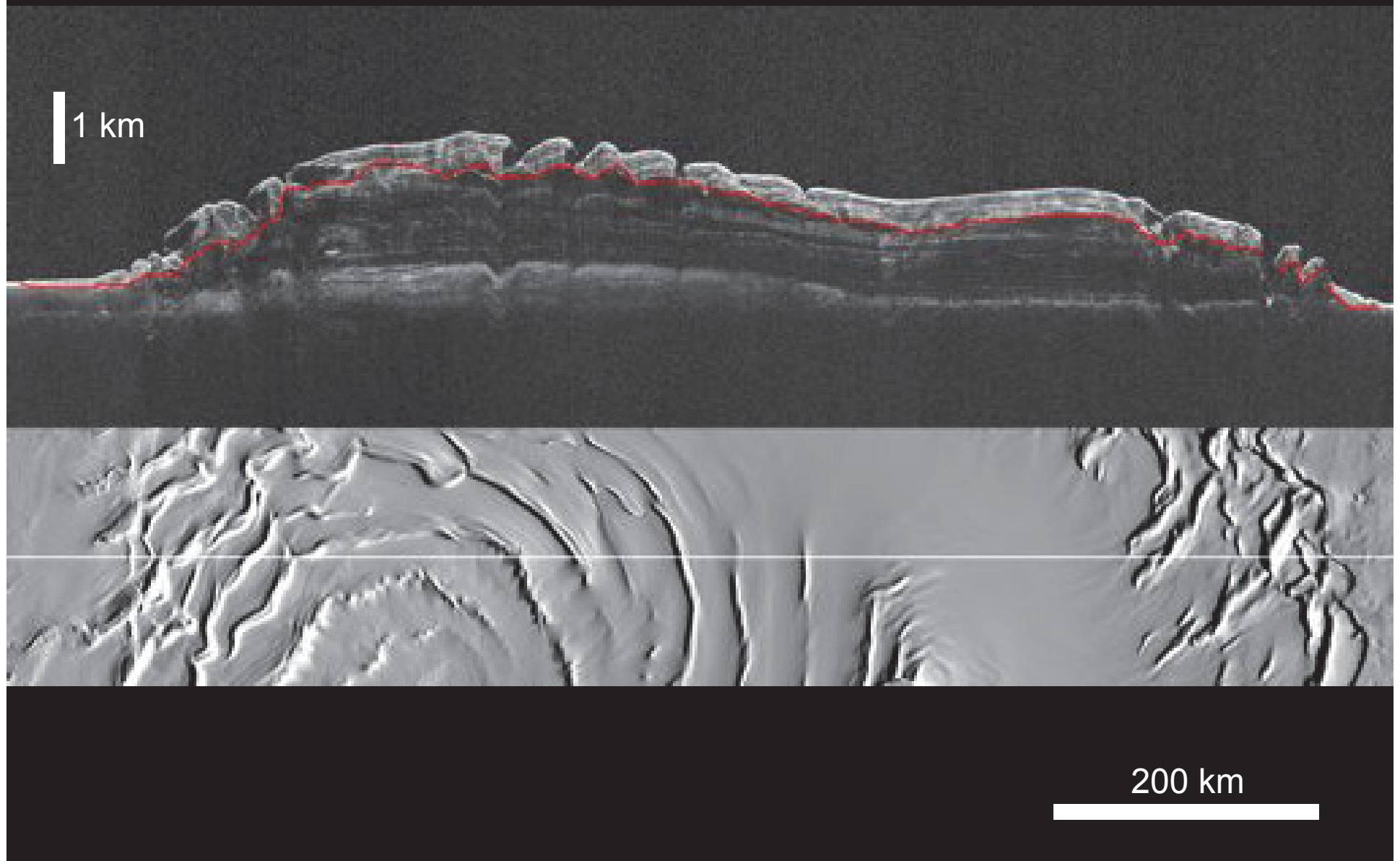
SHARAD 5192 – Depth

1 km

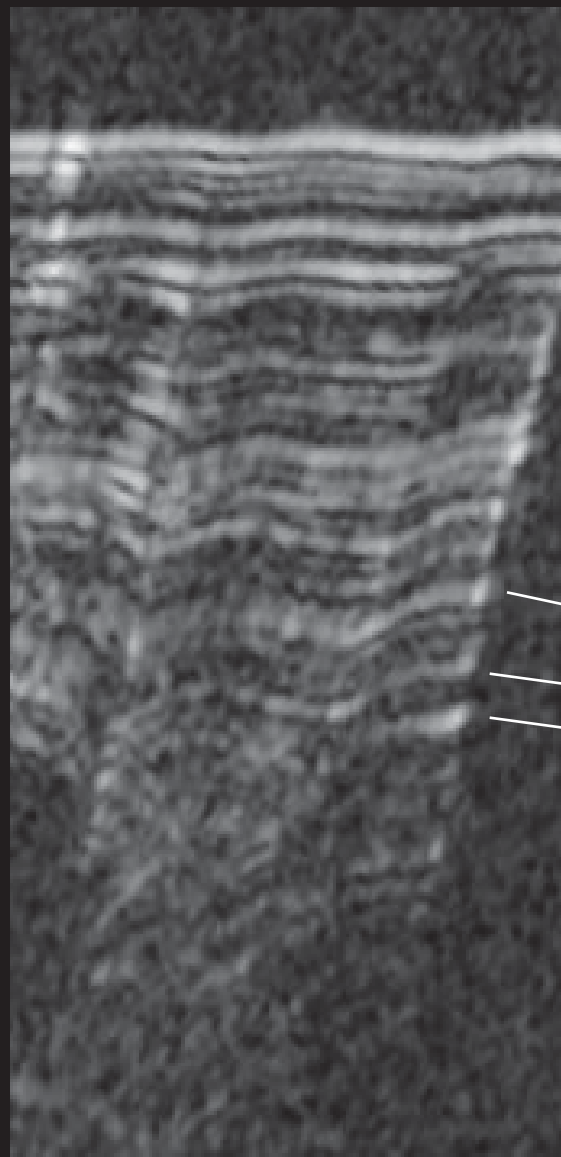


200 km

SHARAD 5192 – Depth

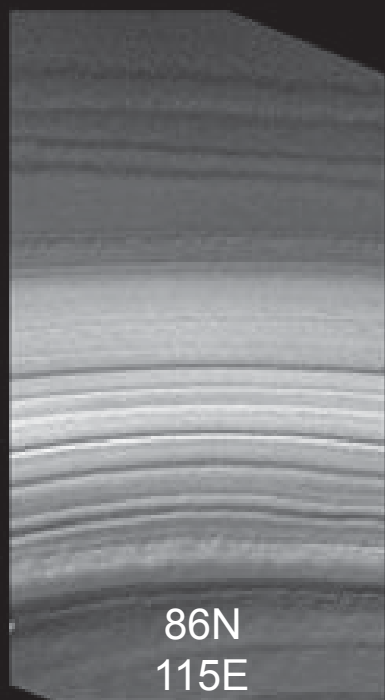


SHARAD 5204 (87.2°N, 95°E)

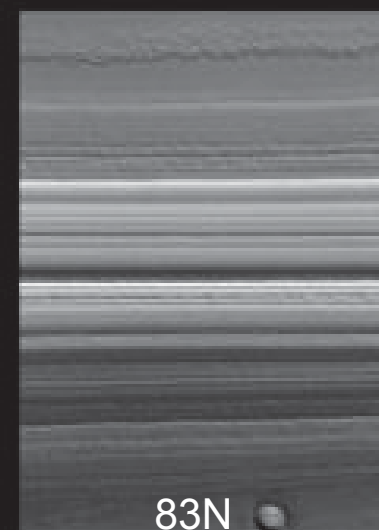
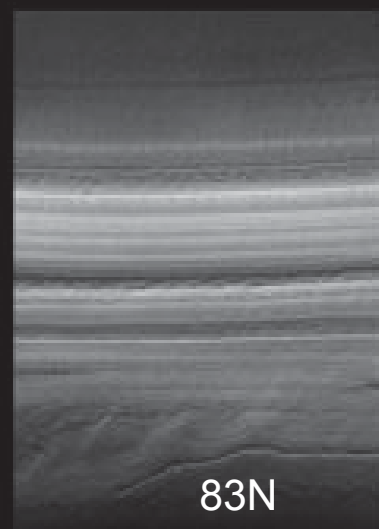
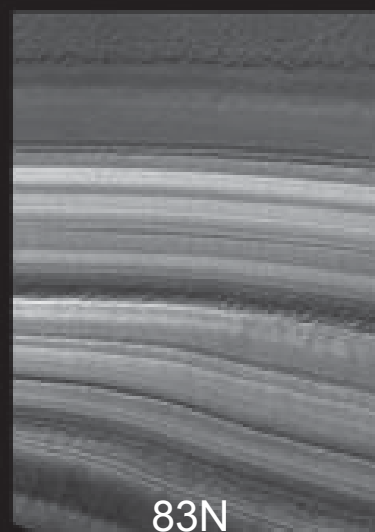
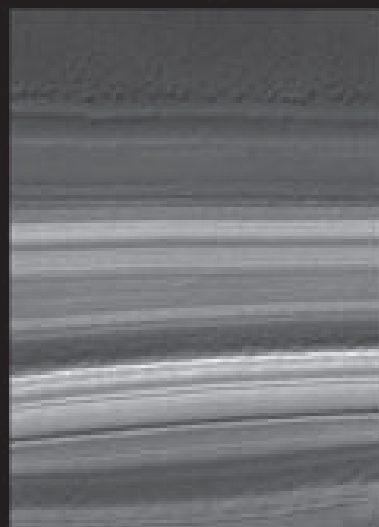


Surface	0 m
Thin multiple bands	
Regional bright band	53 m
Pair of bright bands	75-94 m
Dark packet (multiple thin bands sometimes)	100-180 m
Bright packet: 4-5 bands	192-245 m
Bright band	302 m
Bright band	352 m
Bright band	387 m

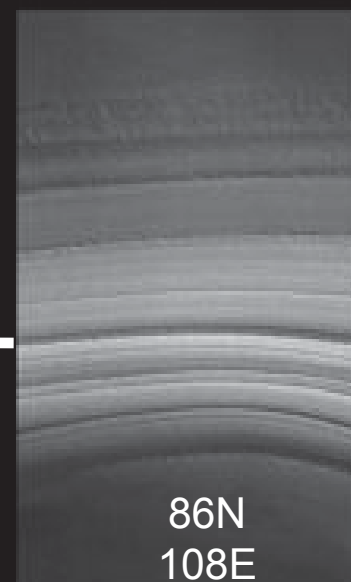
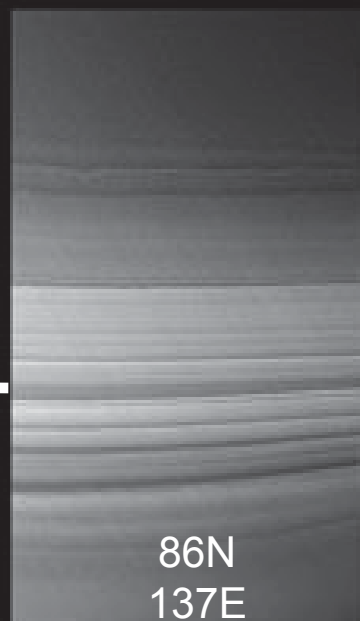
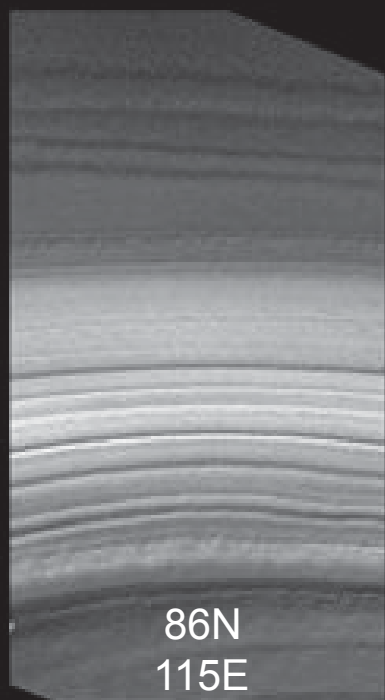
CTX
spring
season



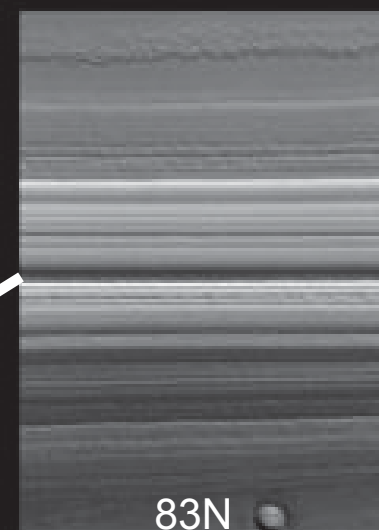
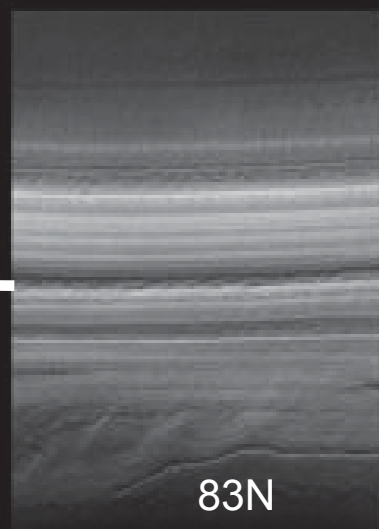
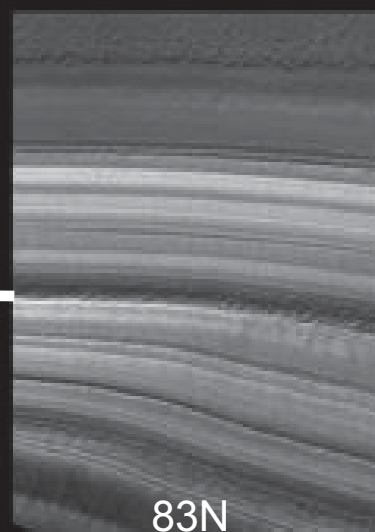
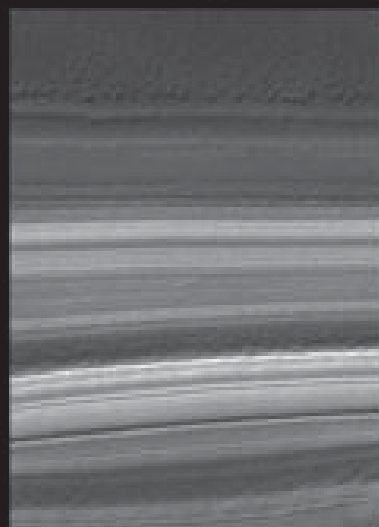
2 km

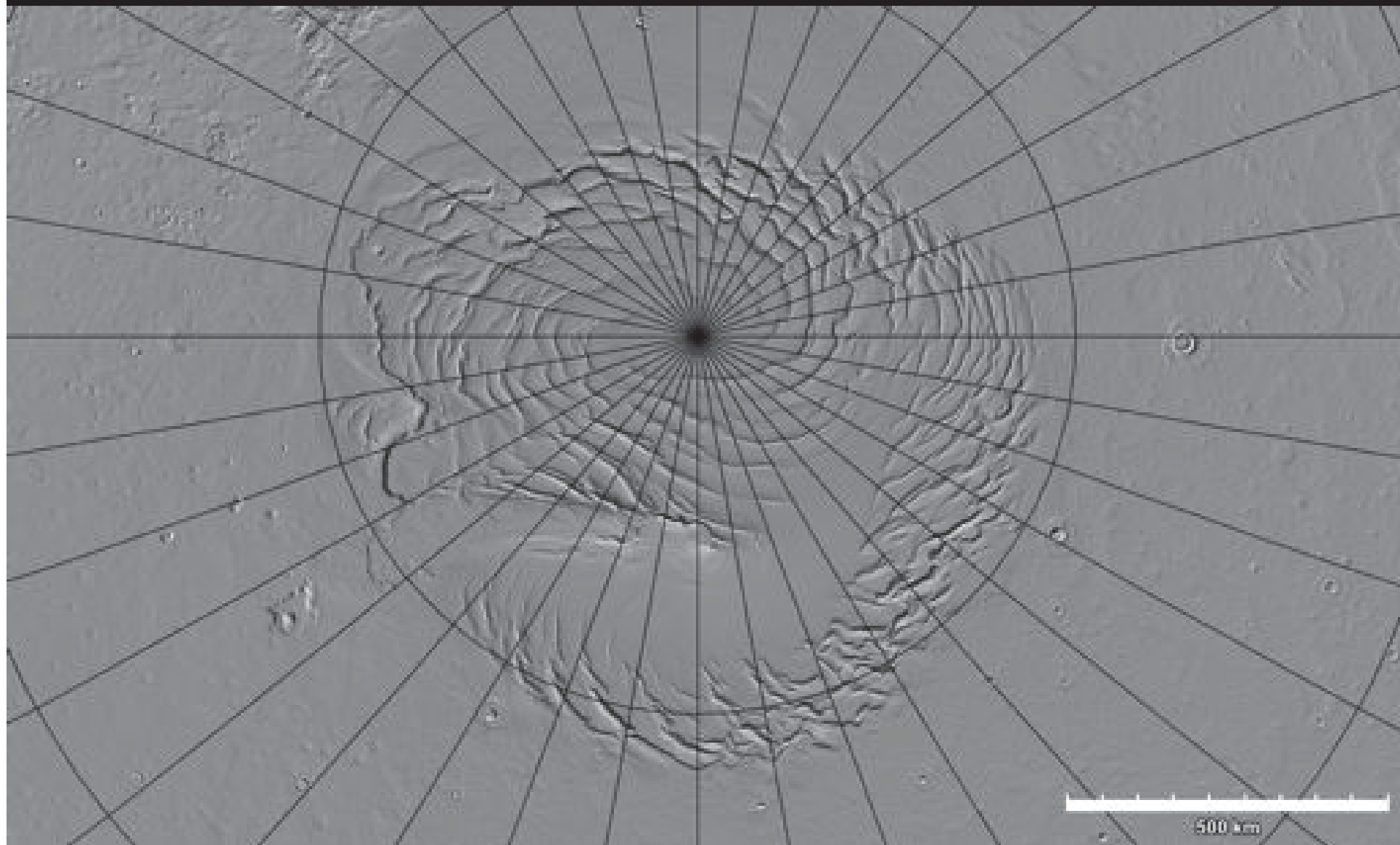


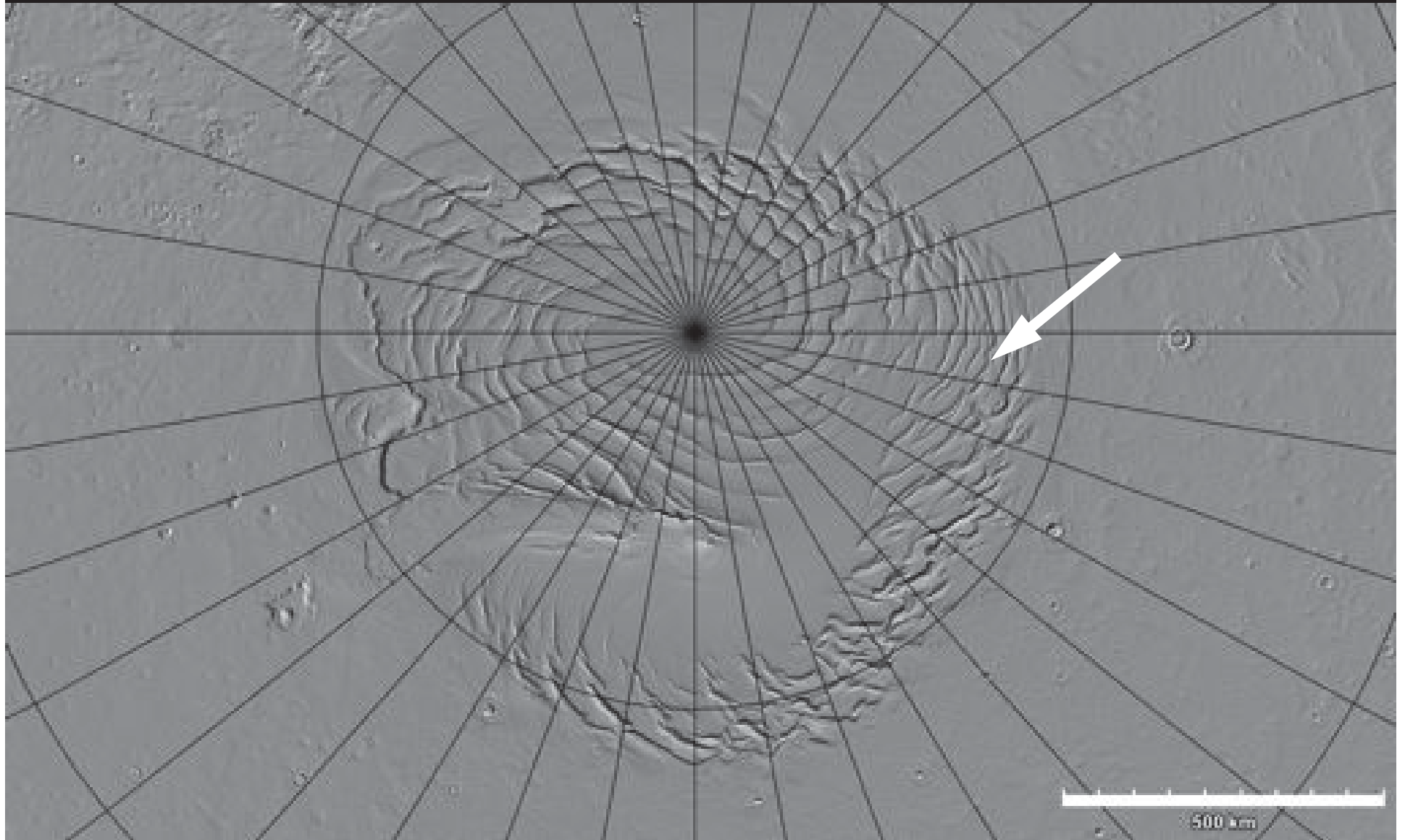
CTX
spring
season

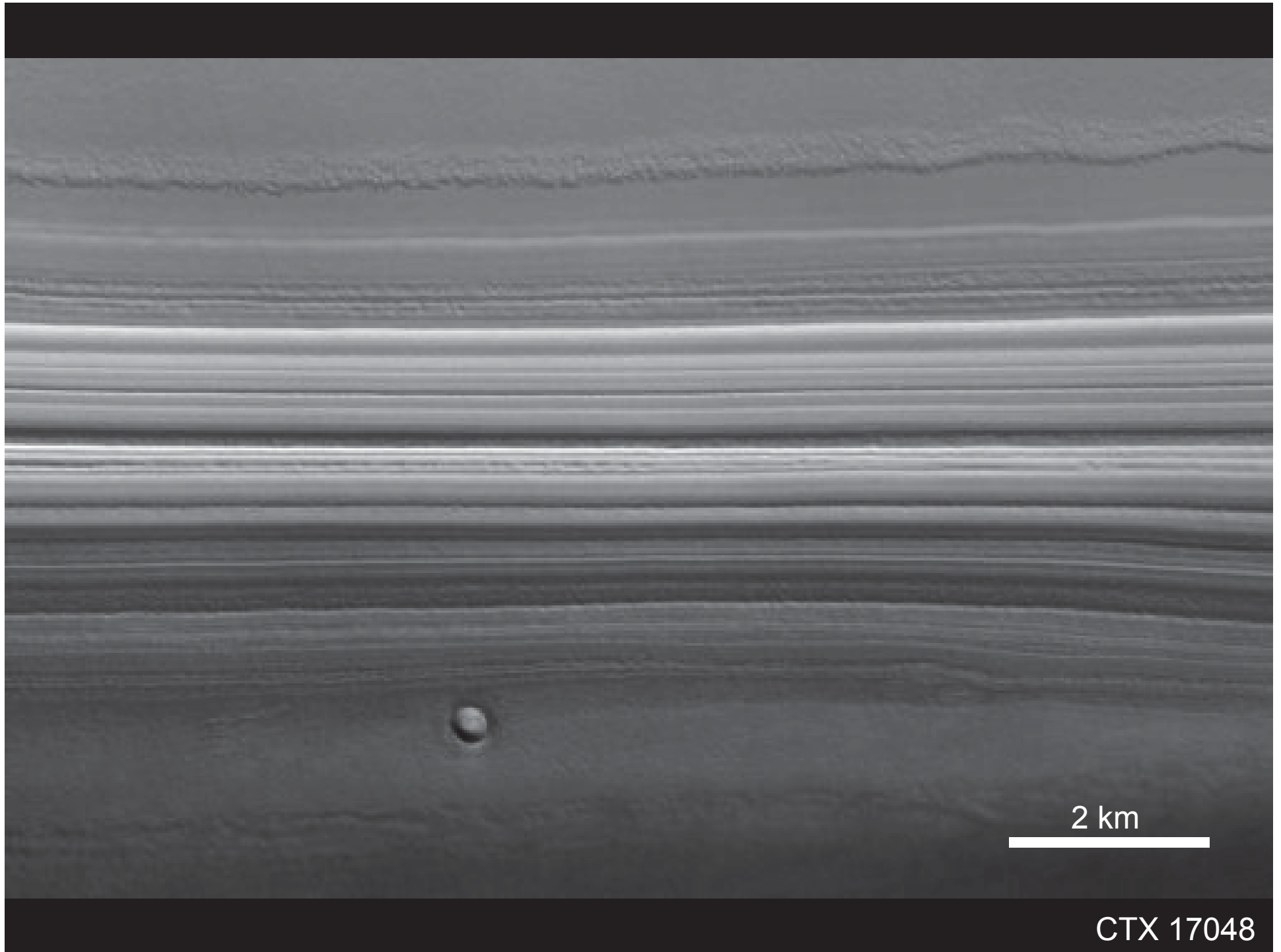


2 km





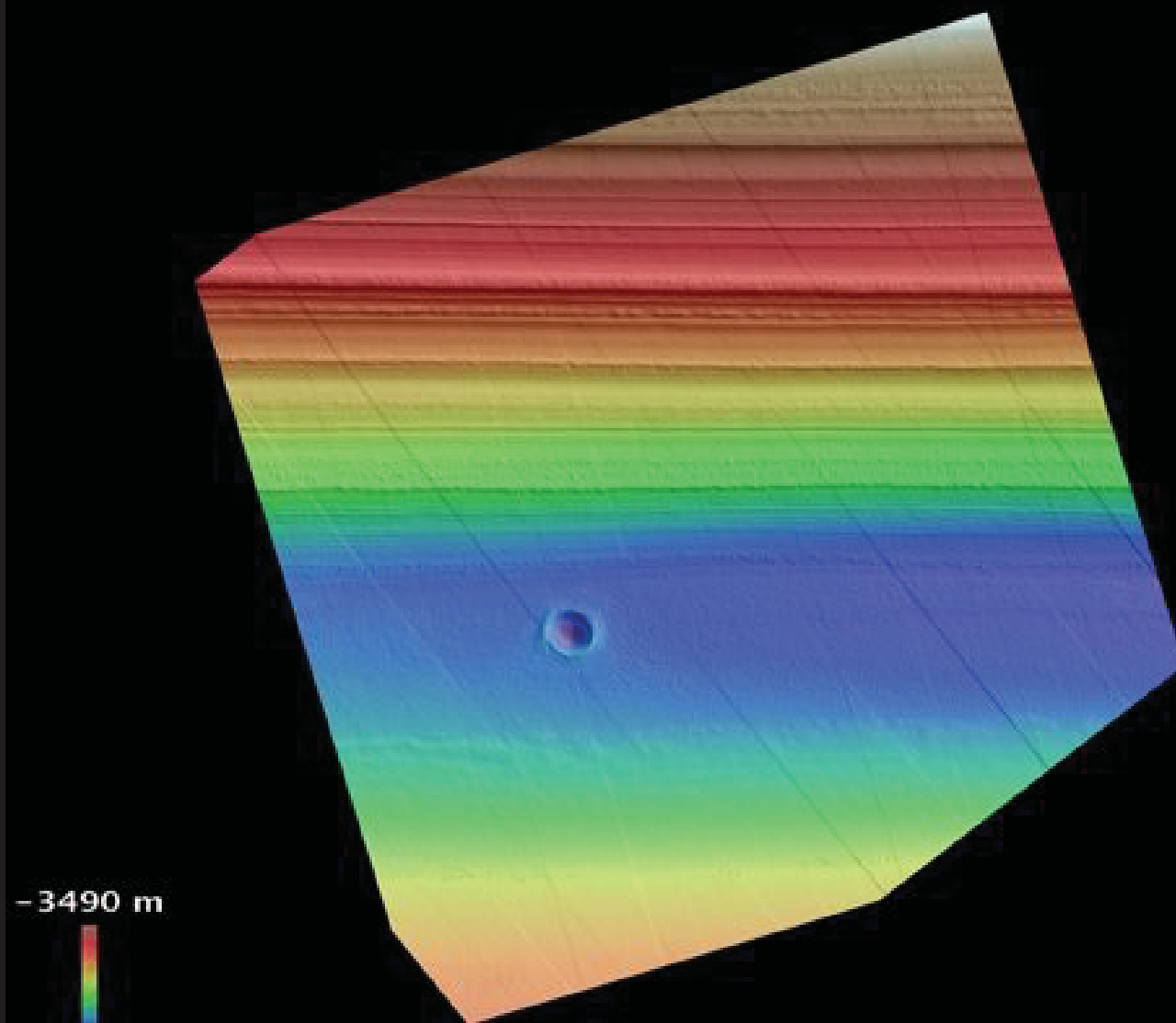




CTX 17048

DTEPC_001462_2630_001580_2630_U01

1000 meters



-3490 m

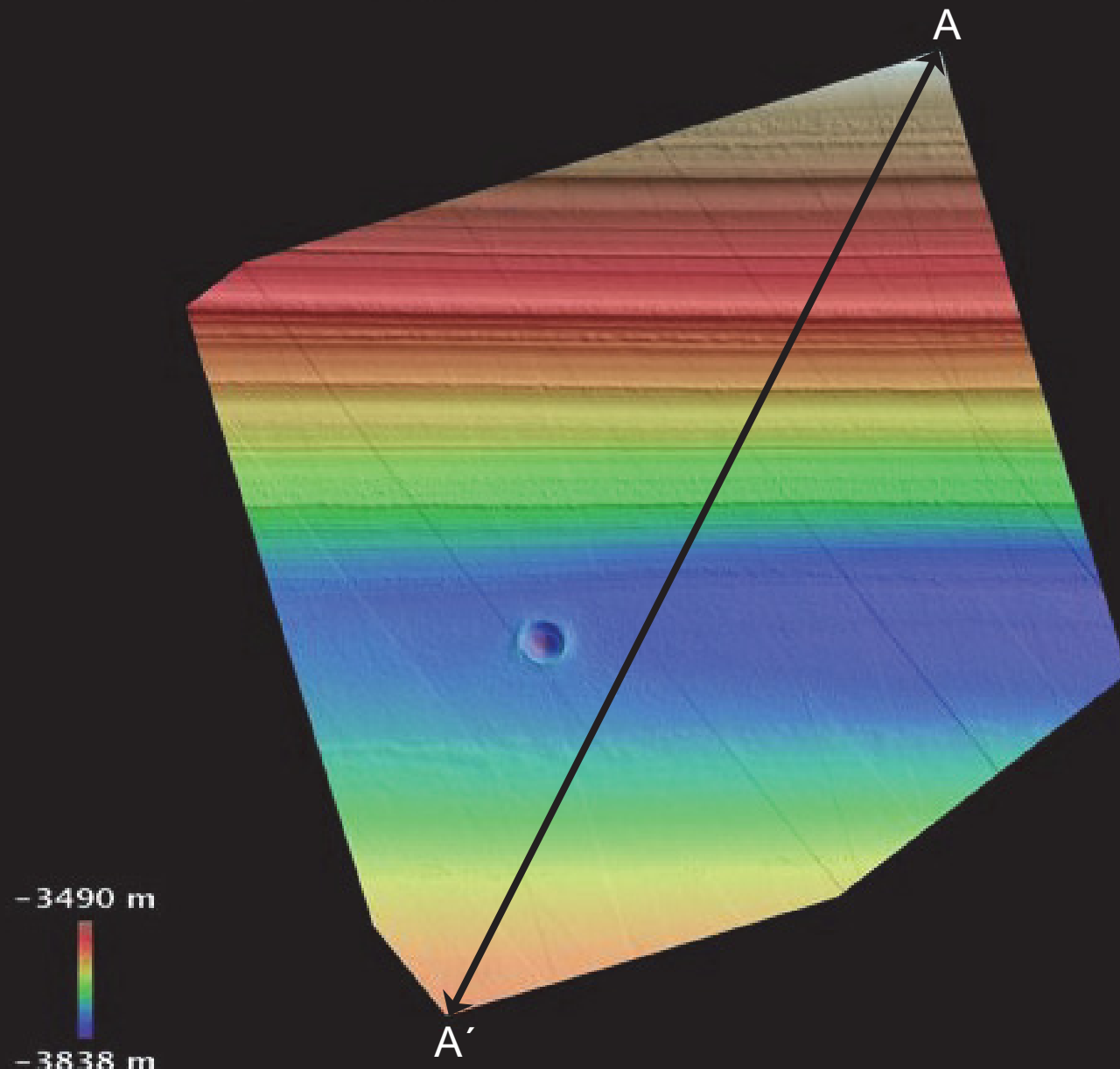
-3838 m

NASA/JPL/University of Arizona/USGS

MRO/HIRISE

DTEPC_001462_2630_001580_2630_U01

1000 meters

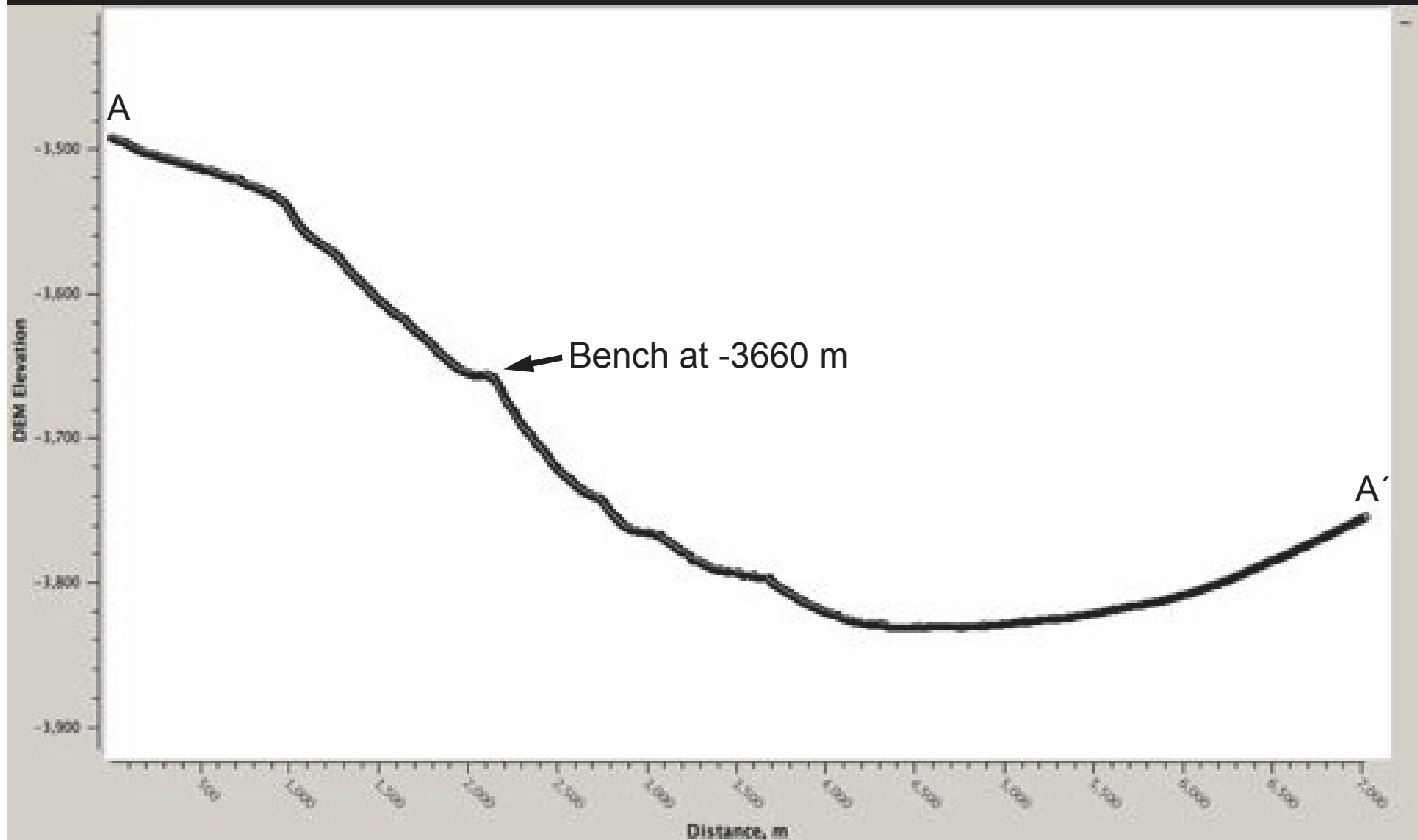


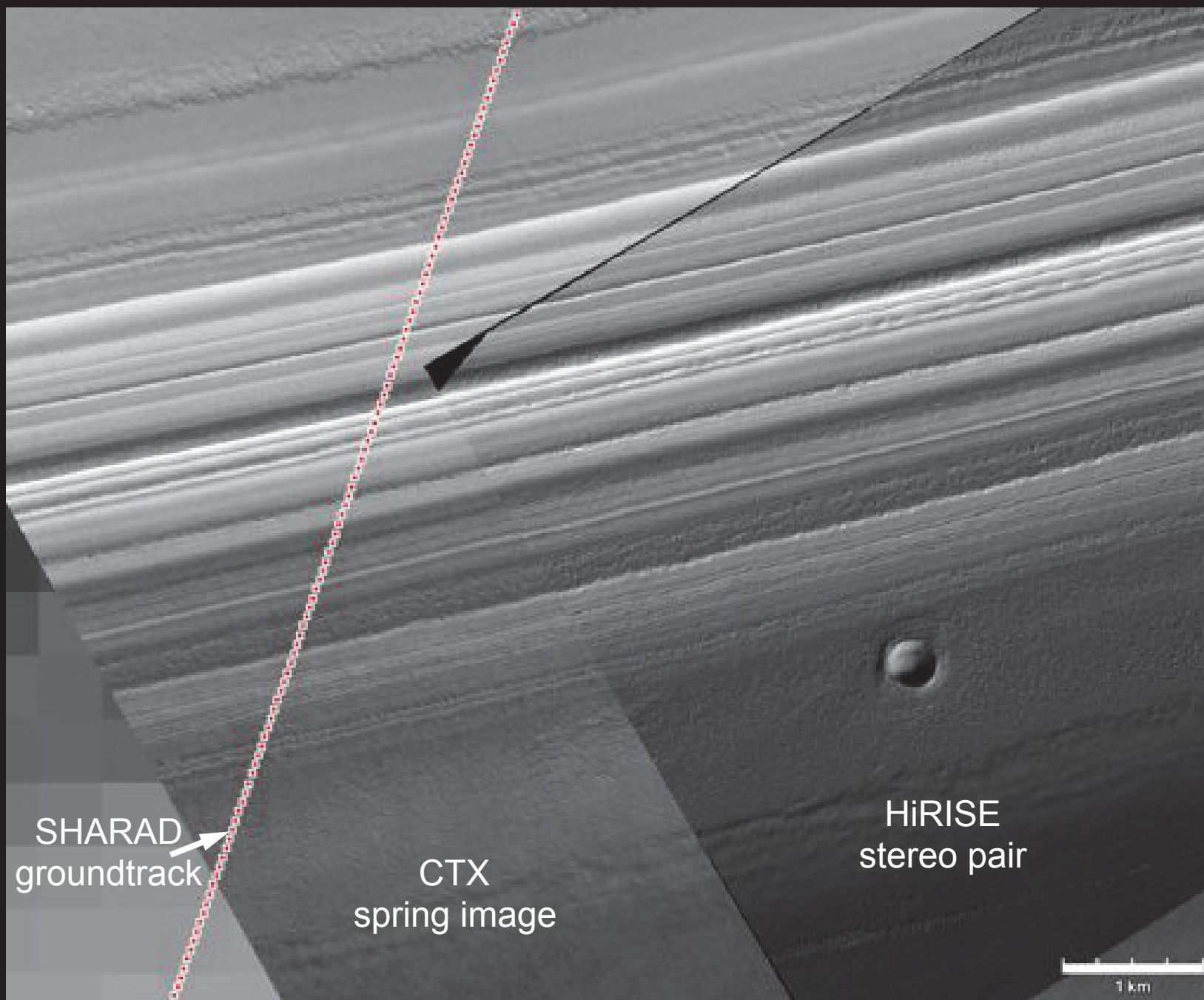
-3490 m

-3838 m

NASA/JPL/University of Arizona/USGS

MRO/HIRISE





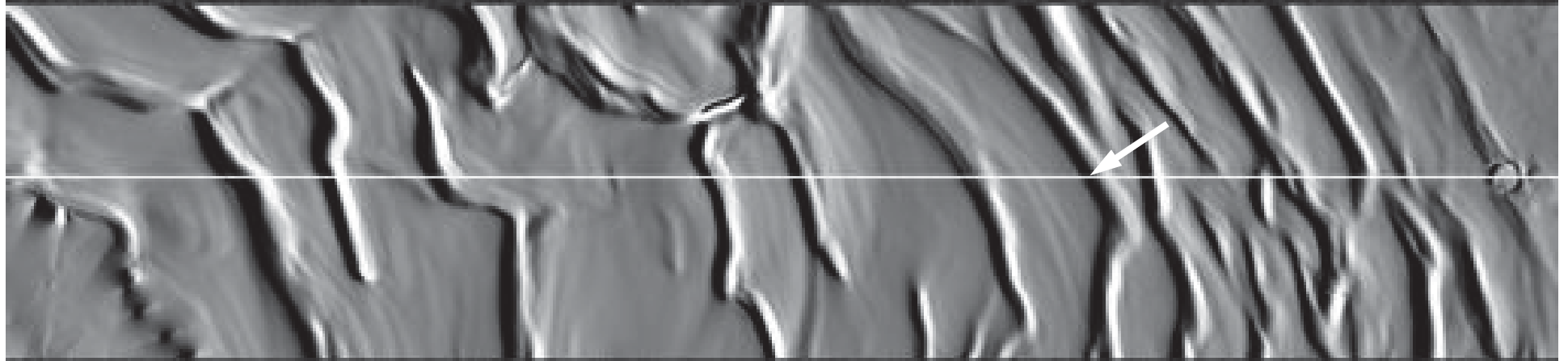
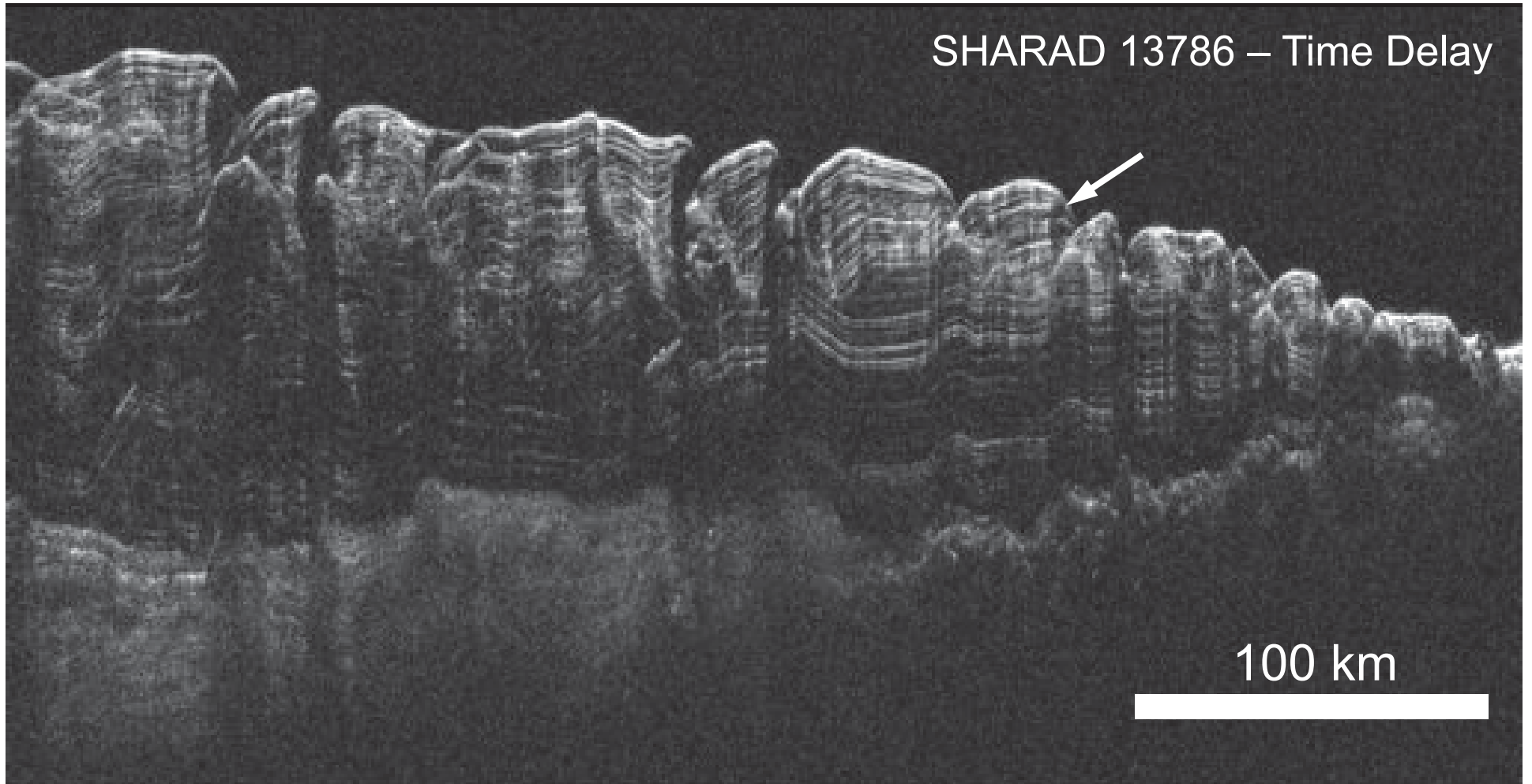
SHARAD
groundtrack

CTX
spring image

HiRISE
stereo pair

1 km

SHARAD 13786 – Time Delay



SHARAD 13786 – Depth

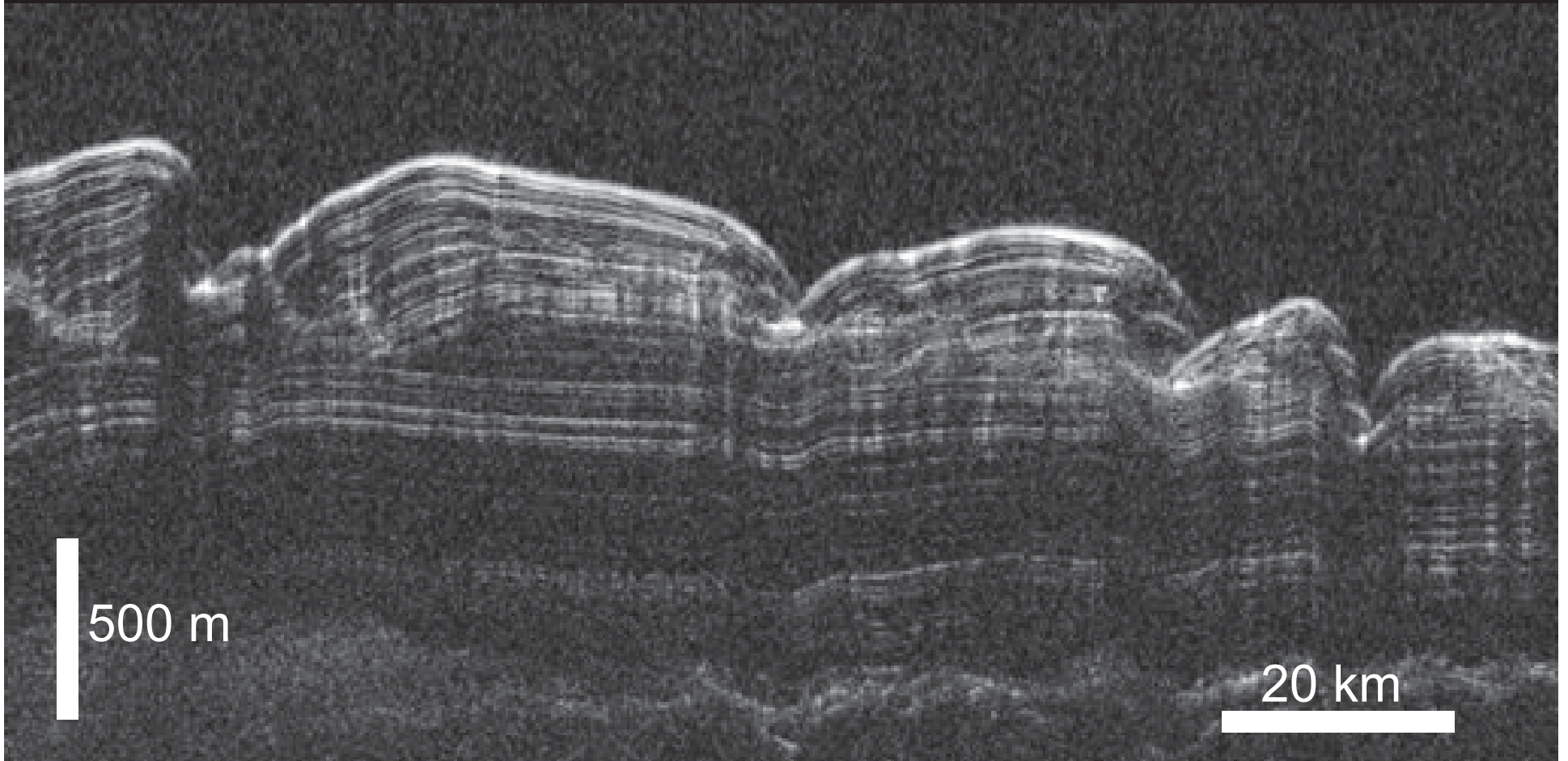


1 km

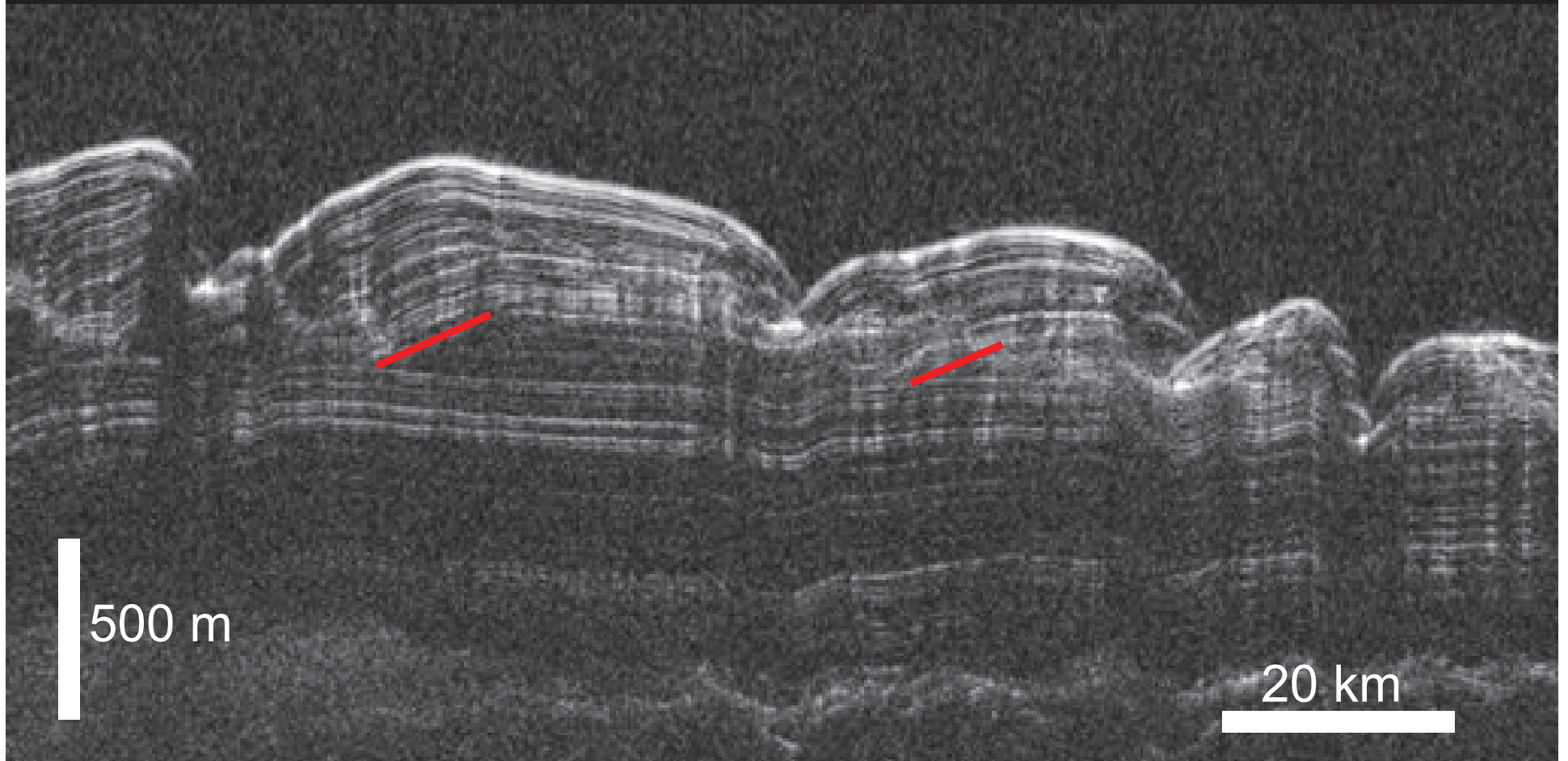
100 km



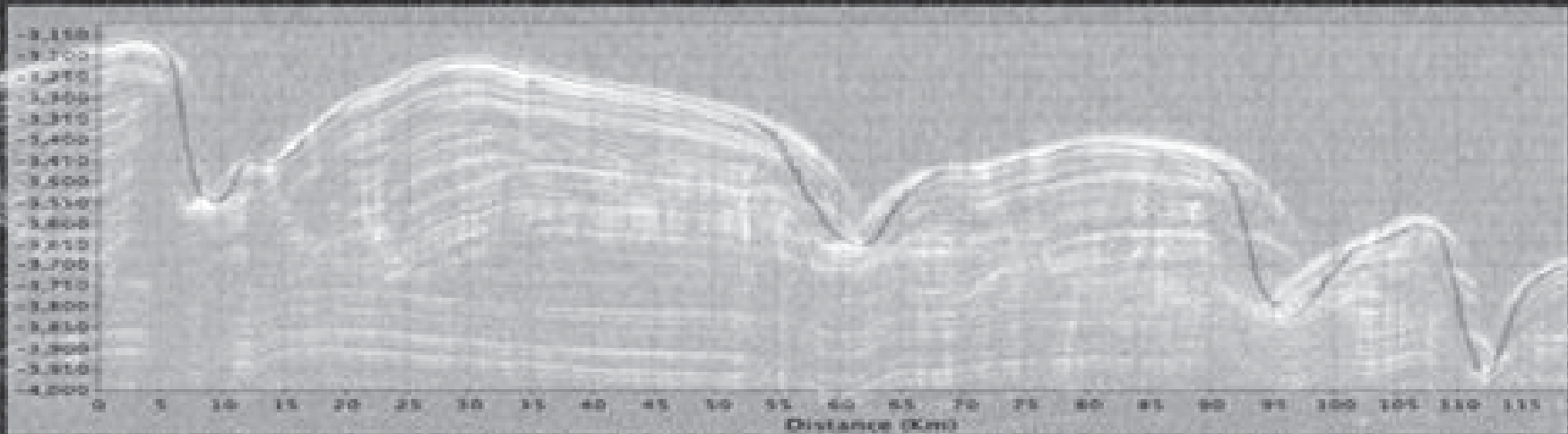
SHARAD 13786 – Depth



SHARAD 13786 – Depth



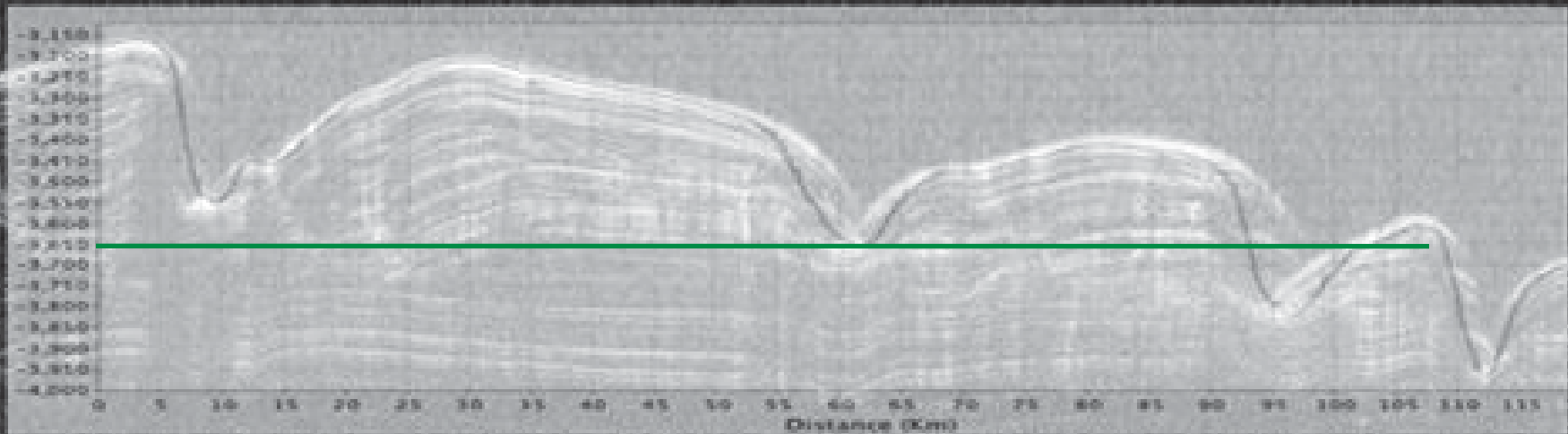
SHARAD 13786 – Depth



500 m

20 km

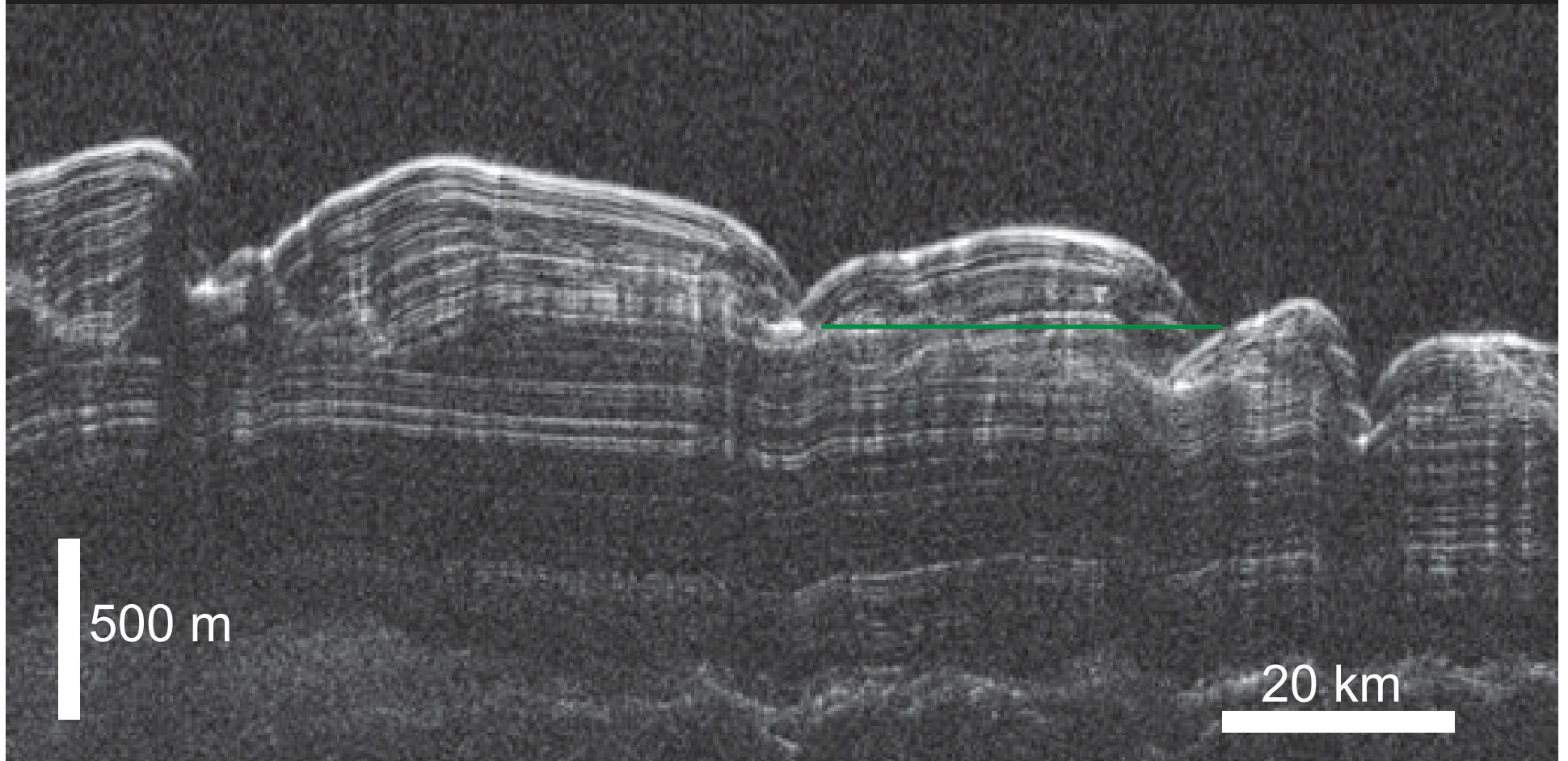
SHARAD 13786 – Depth



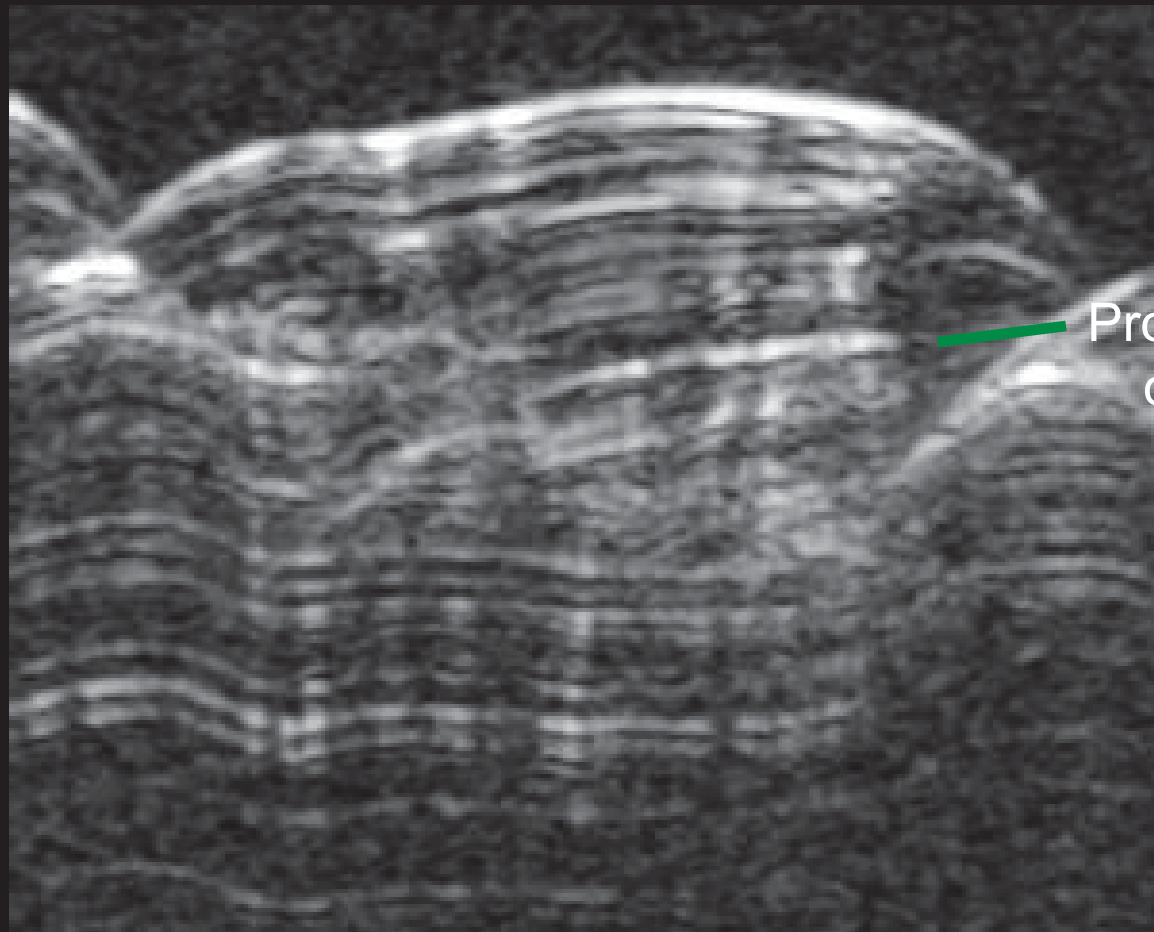
500 m

20 km

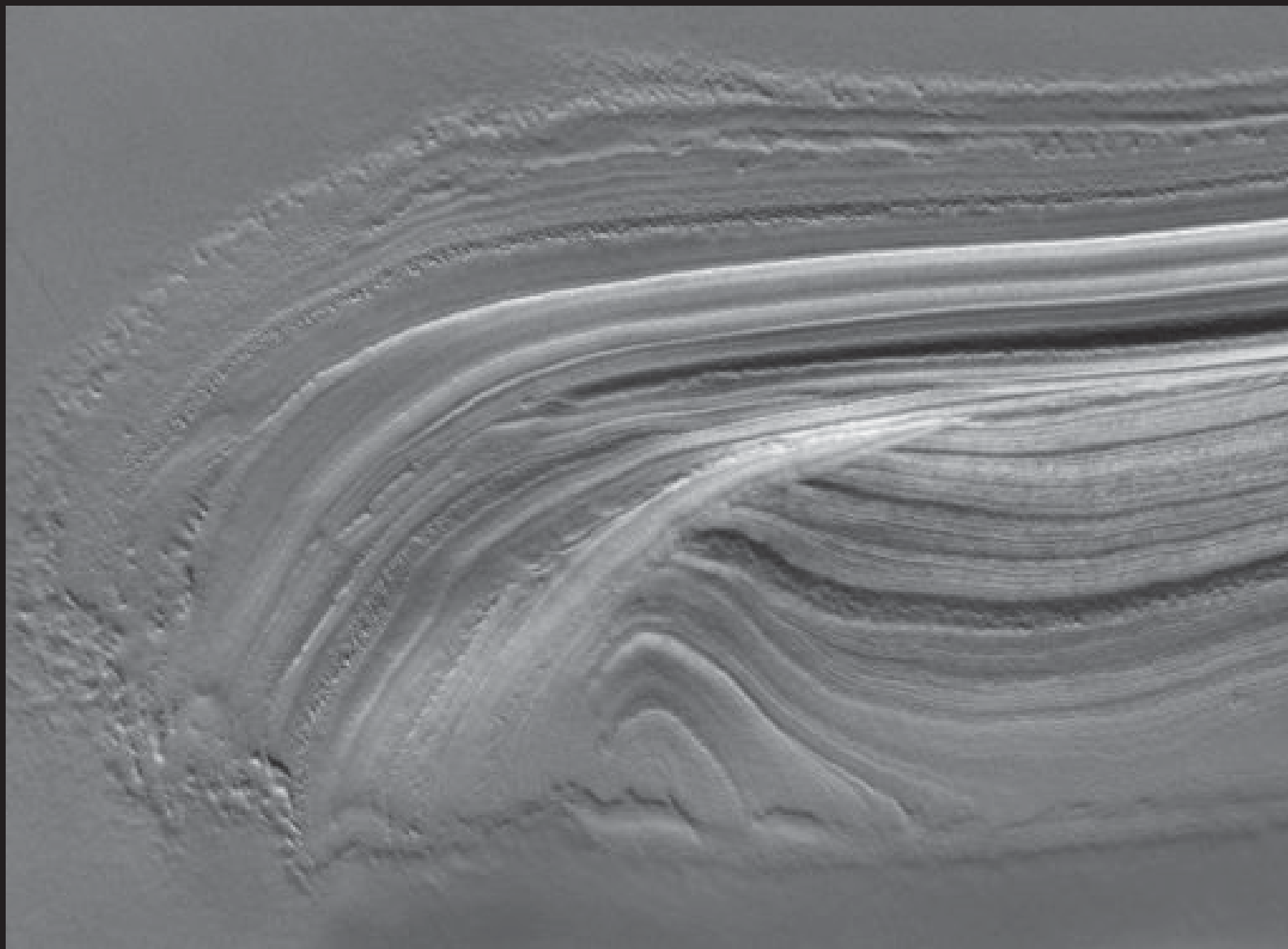
SHARAD 13786 – Depth



SHARAD 13786 – Time Delay



Projected elevation
of “U2” bench



CTX 7634

82N,80E

2 km

Summary

- The upper ~400 m of the NPLD are a continuous stack, representing the last major episode of deposition.
- The upper, middle and lower sections of this stack are marked by distinctive layers, in radar and image data.
- Bright reflectors in SHARAD are often associated with resistant layers in outcrop.
 - No obvious relationship to visible albedo.
 - What layer characteristic produces a radar reflection and erosion resistance?
- The NPLD section below the upper ~400 m stack is riddled with unconformities, marking a previous epoch dominated by erosion (similar to recent?).

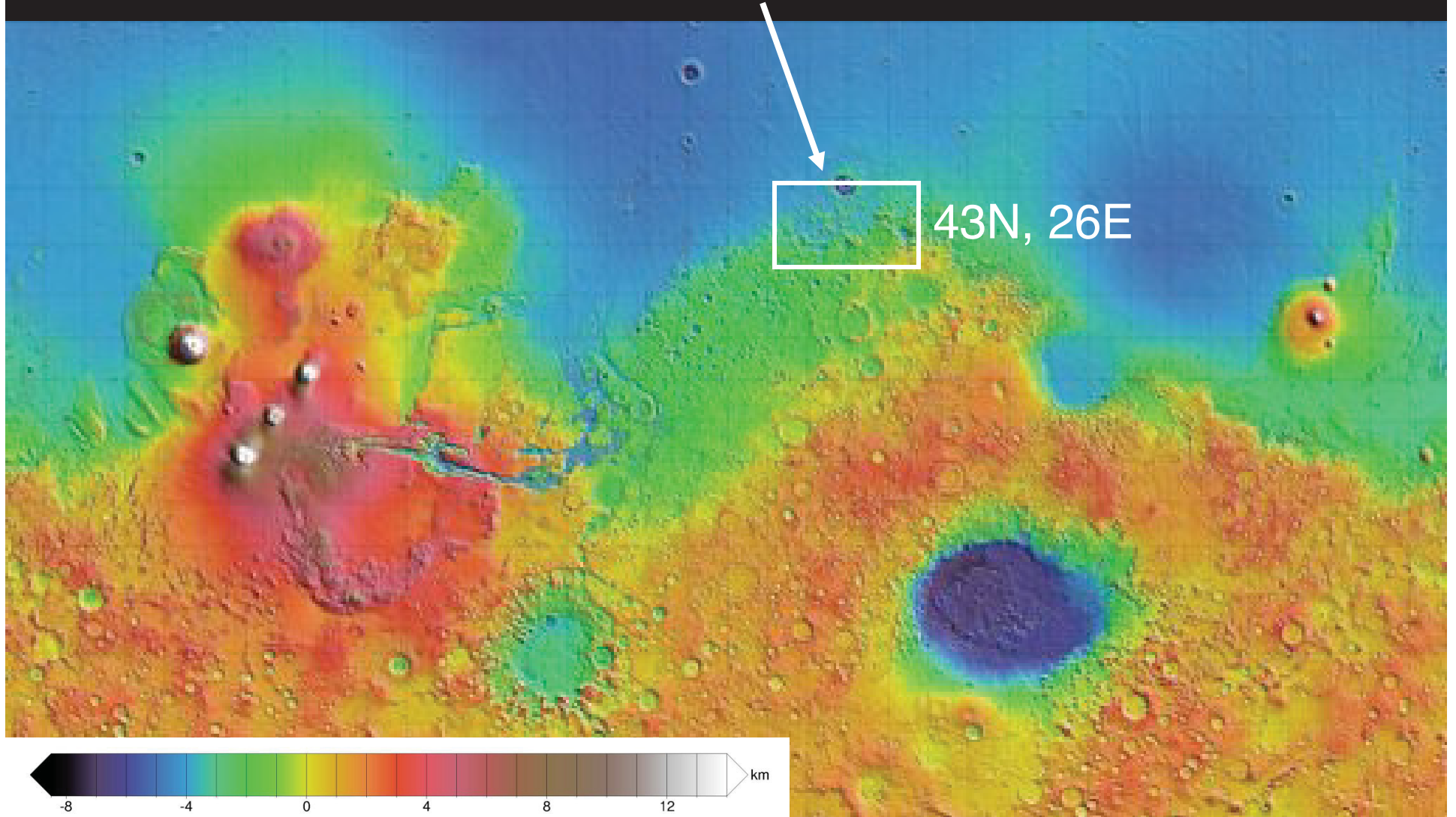
Thick Ice Deposits in Deuteronilus Mensae, Mars: Regional Distribution from Radar Sounding

J. J. Plaut

Outline

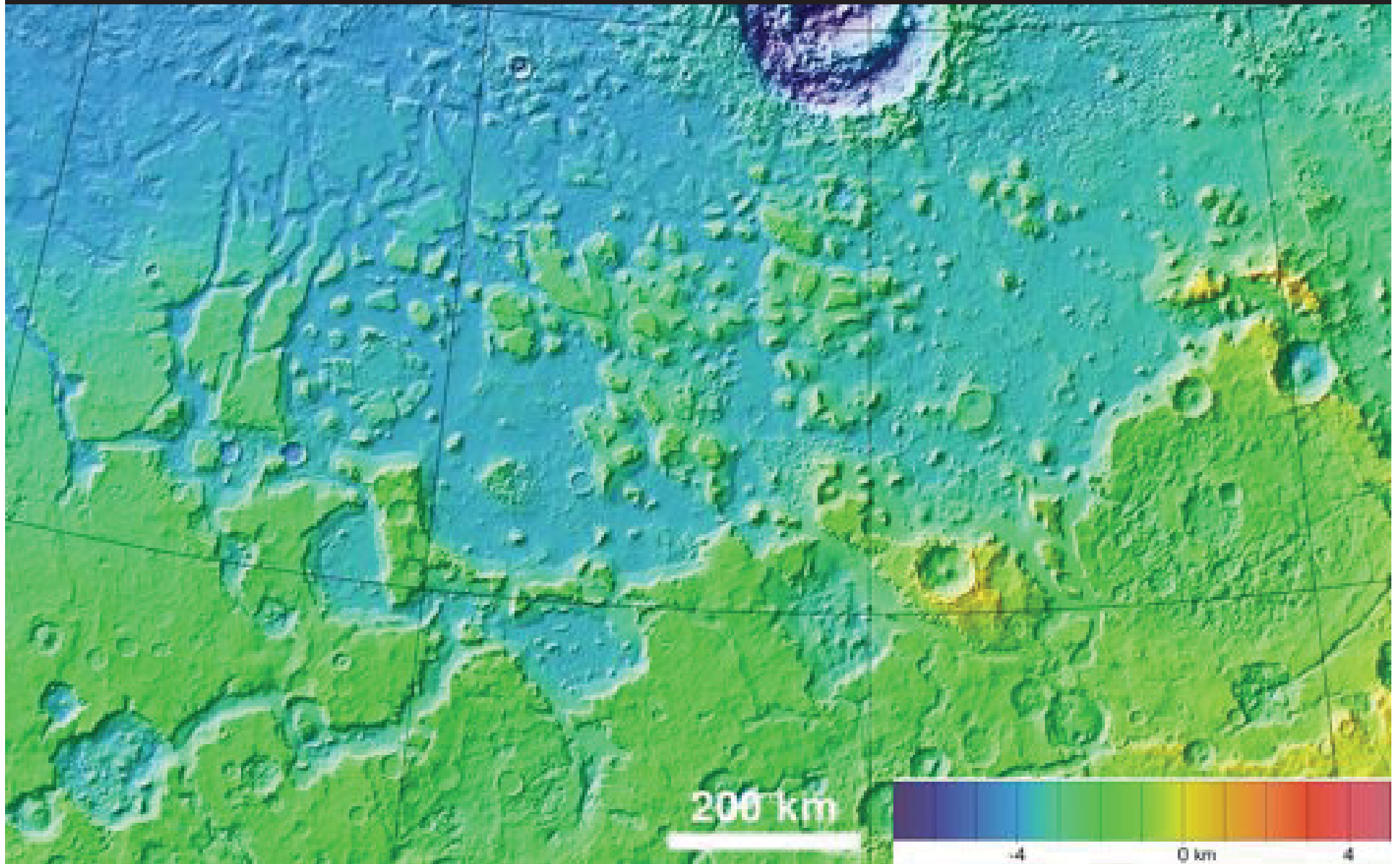
- Review of the Deuteronilus area
- Examples of SHARAD detections
- Mapping criteria
- Occurrence, regional trends, volume estimate

Deuteronilus Mensae



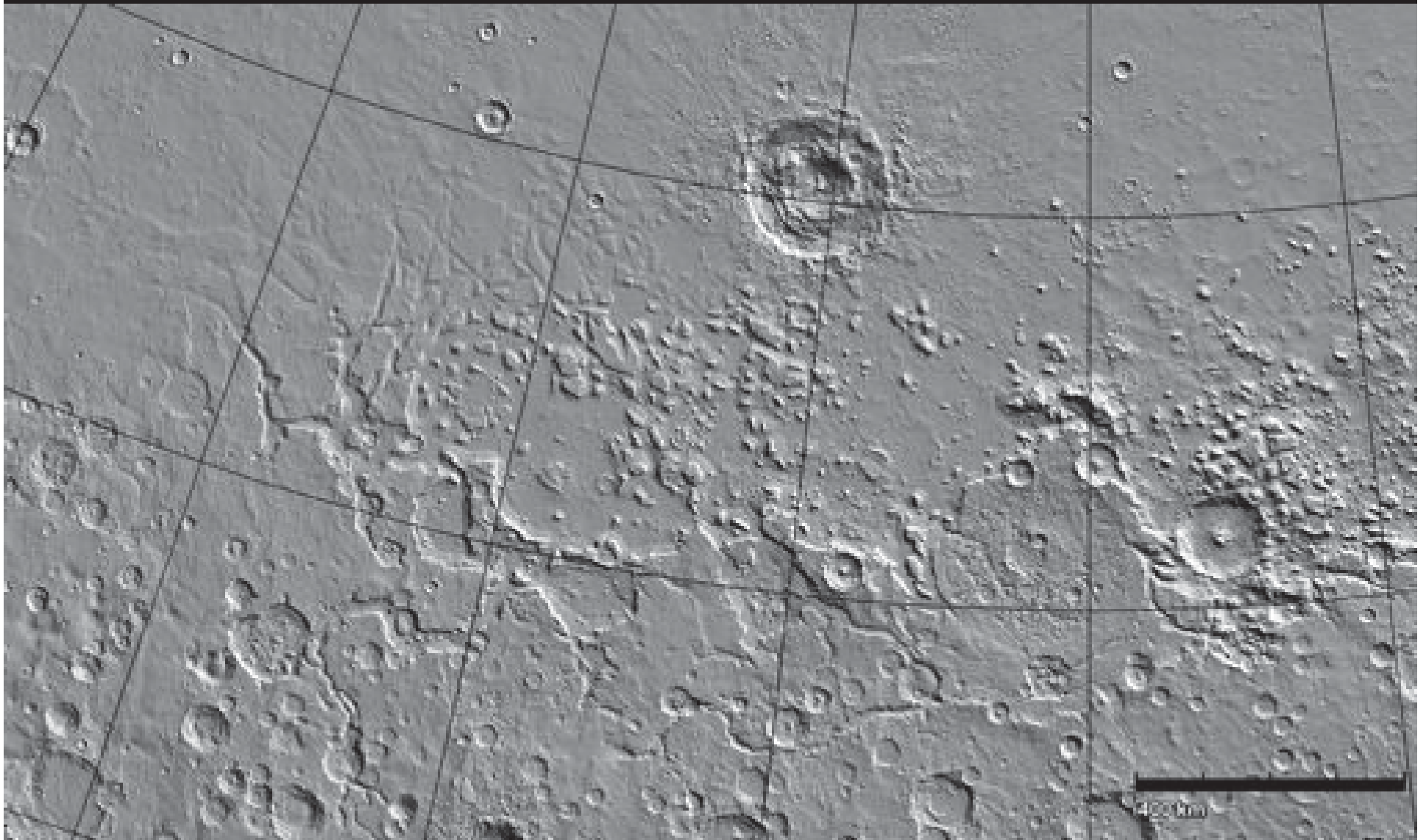
MOLA Elevation – NASA/GSFC

Deuteronilus Mensae

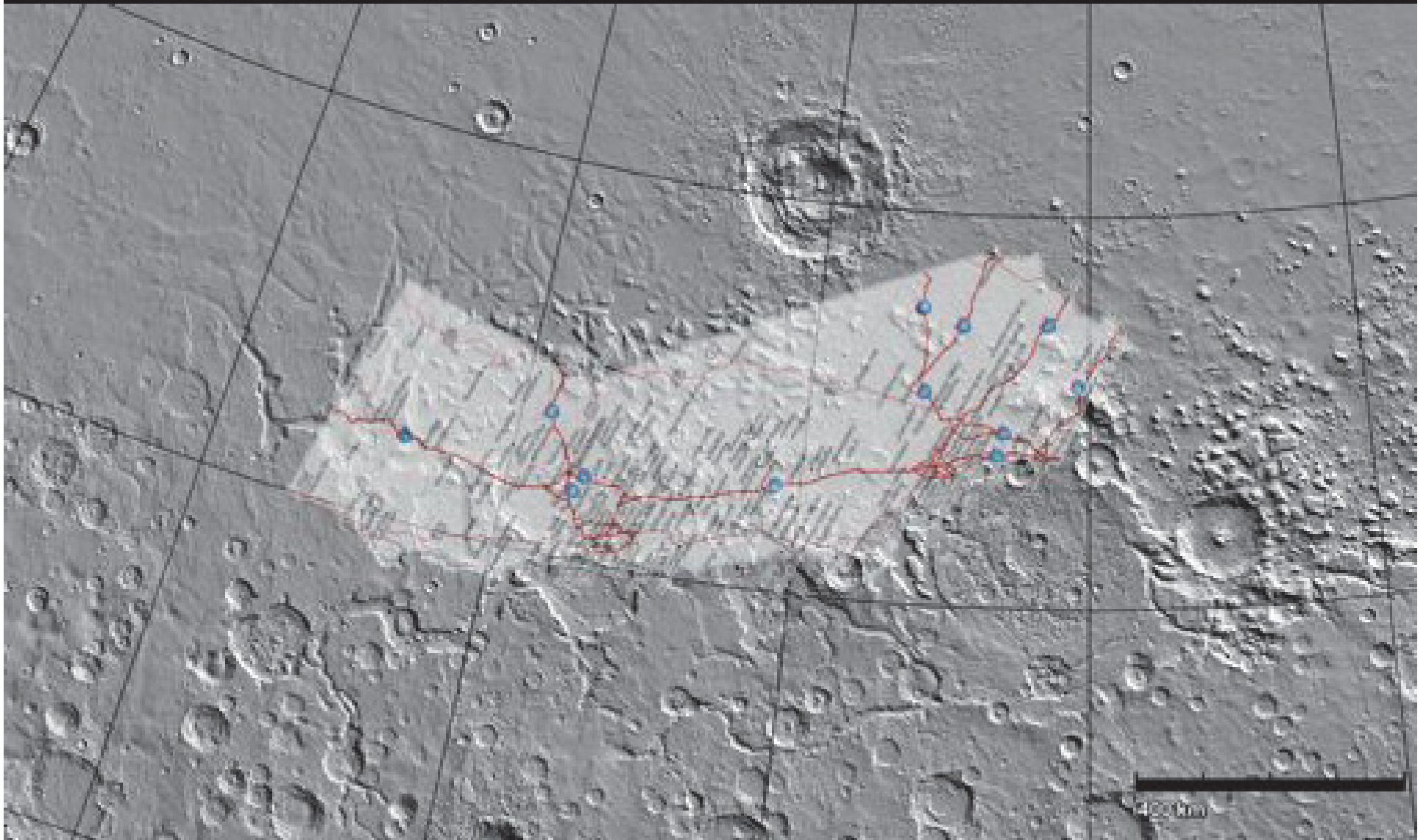


MOLA Team

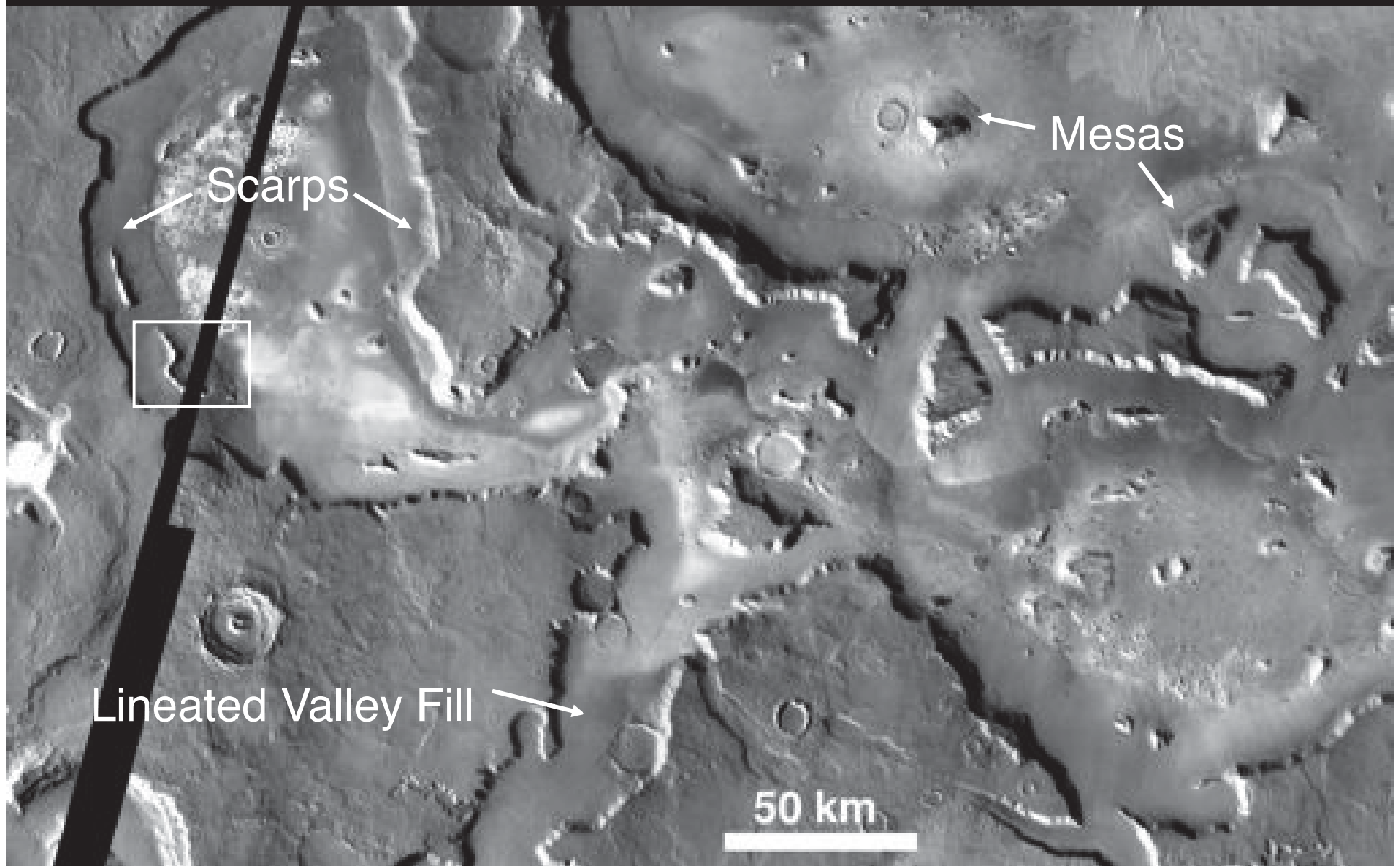
A Big Place

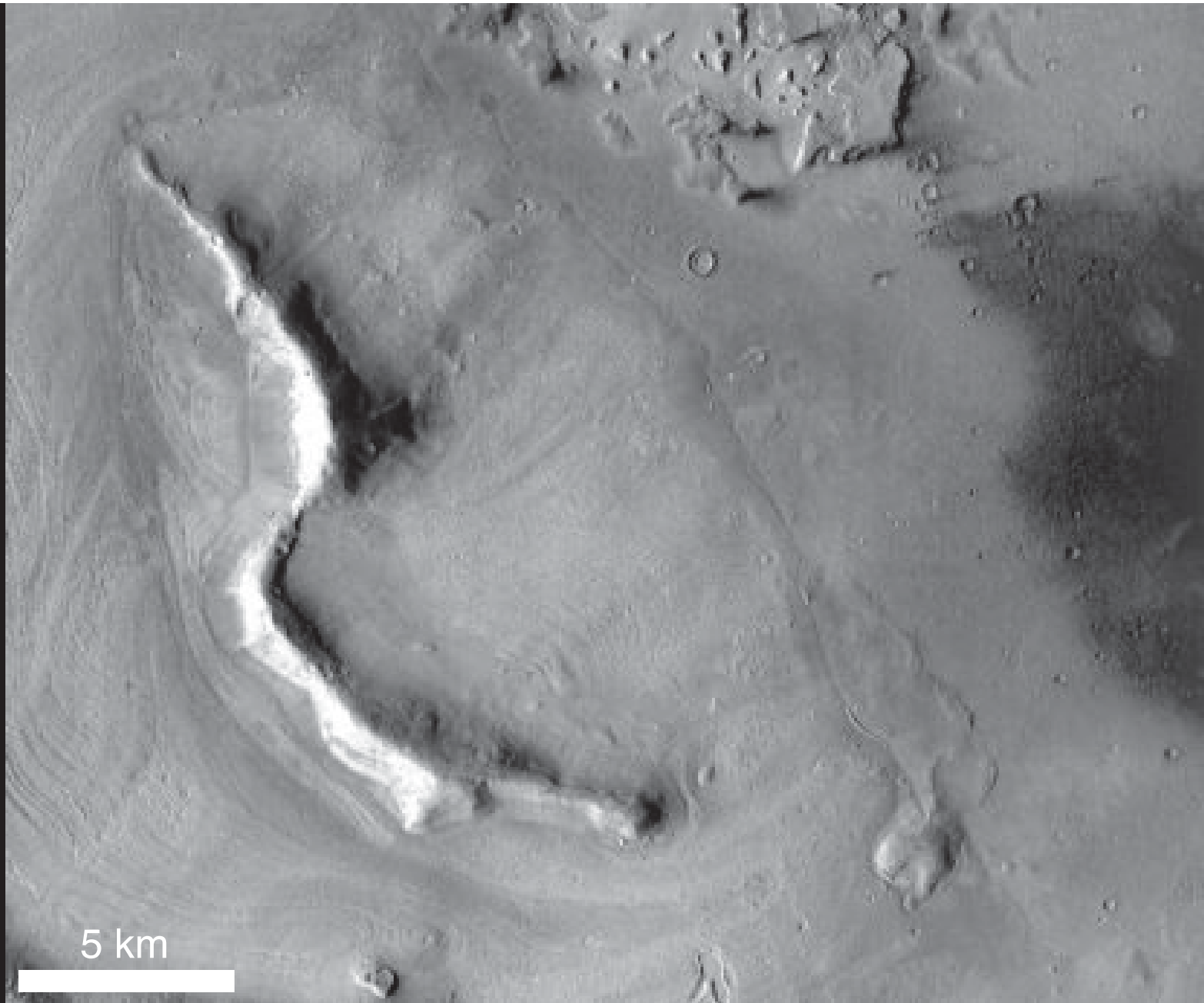


A Big Place

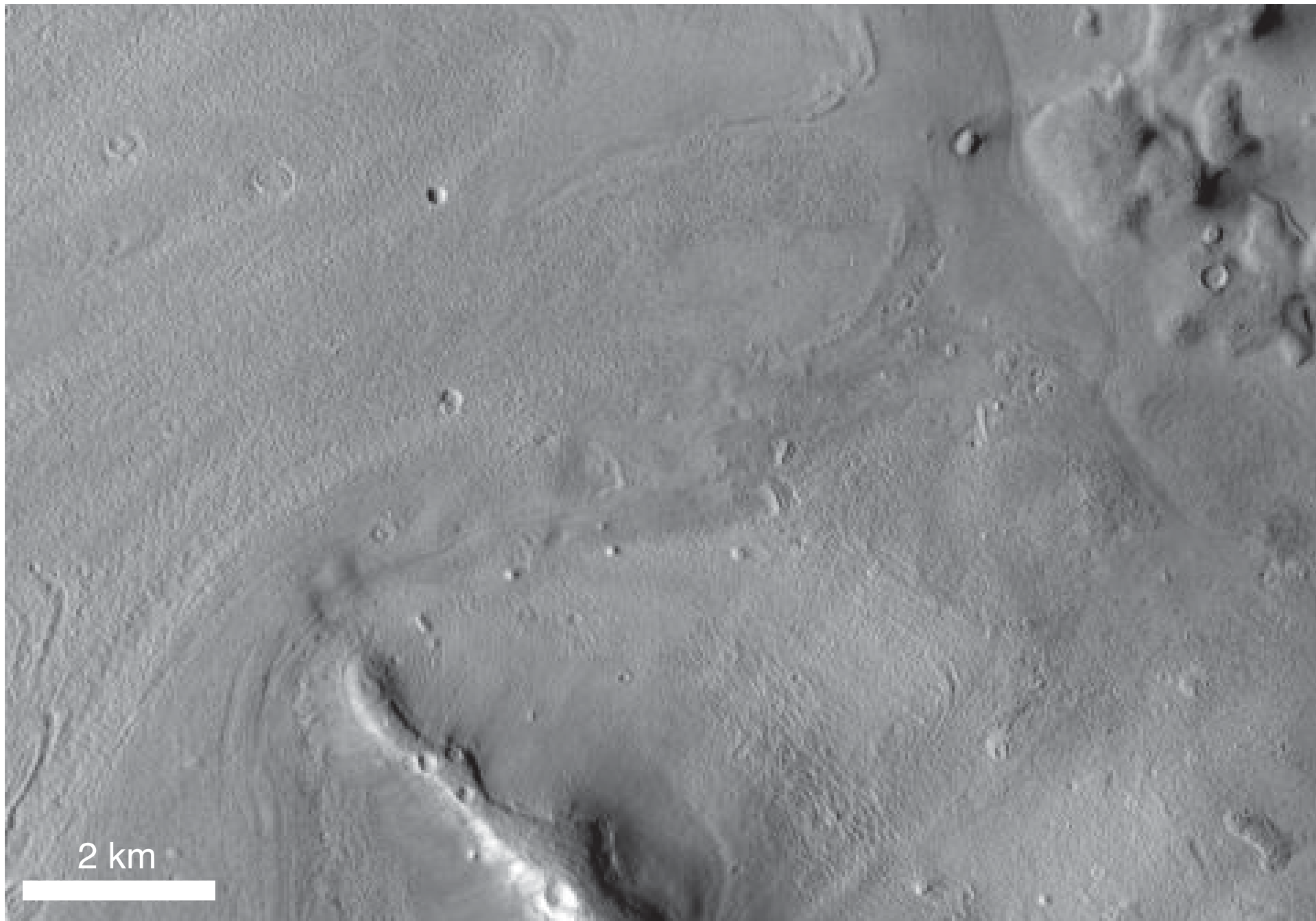


Geomorphic Settings of Lobate Aprons





CTX - MSSS



CTX - MSSS

SHARAD Sounding of Lobate Aprons

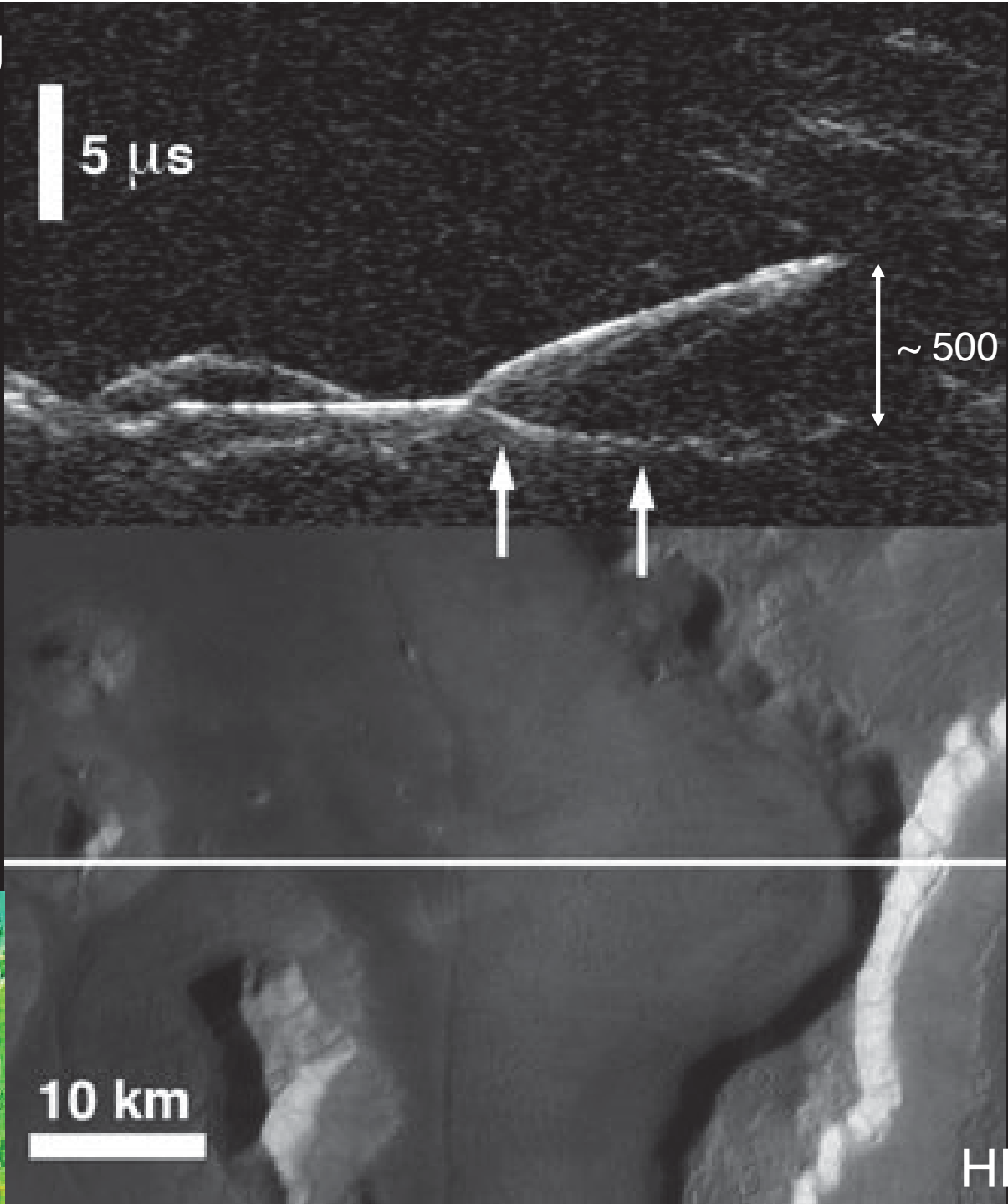
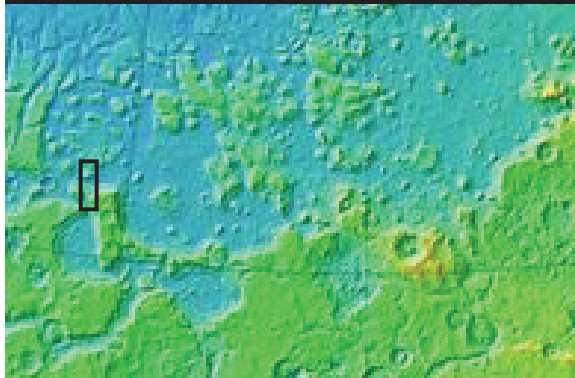
2145_01

5 μ s

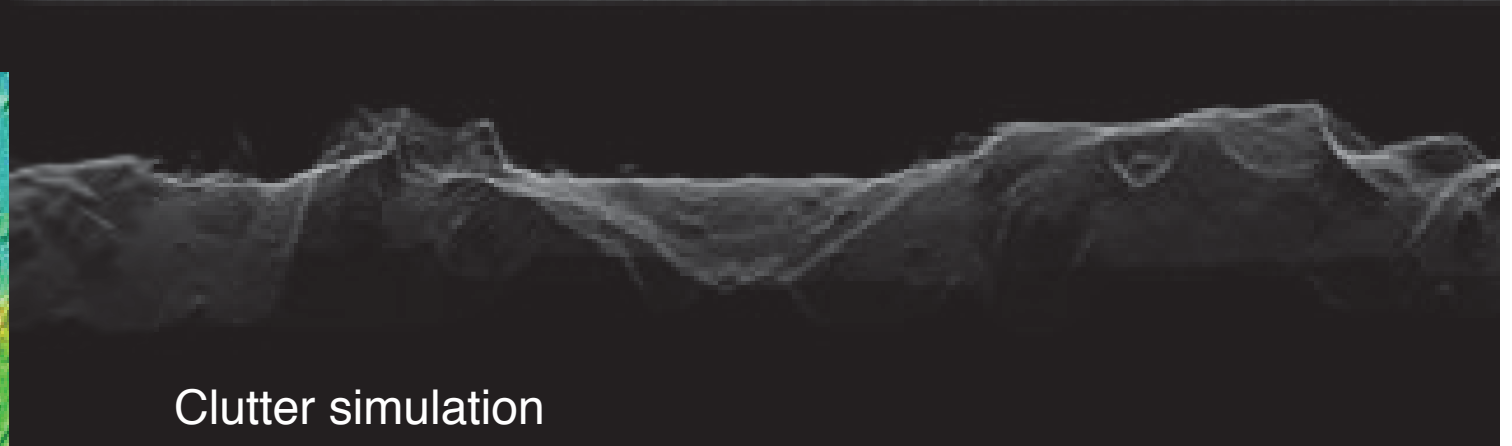
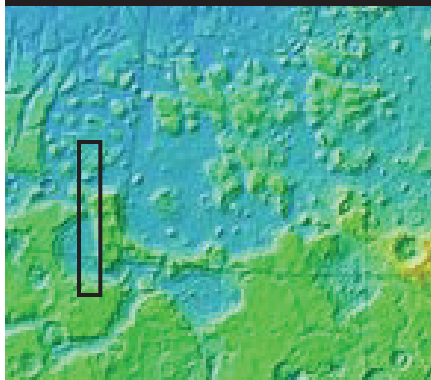
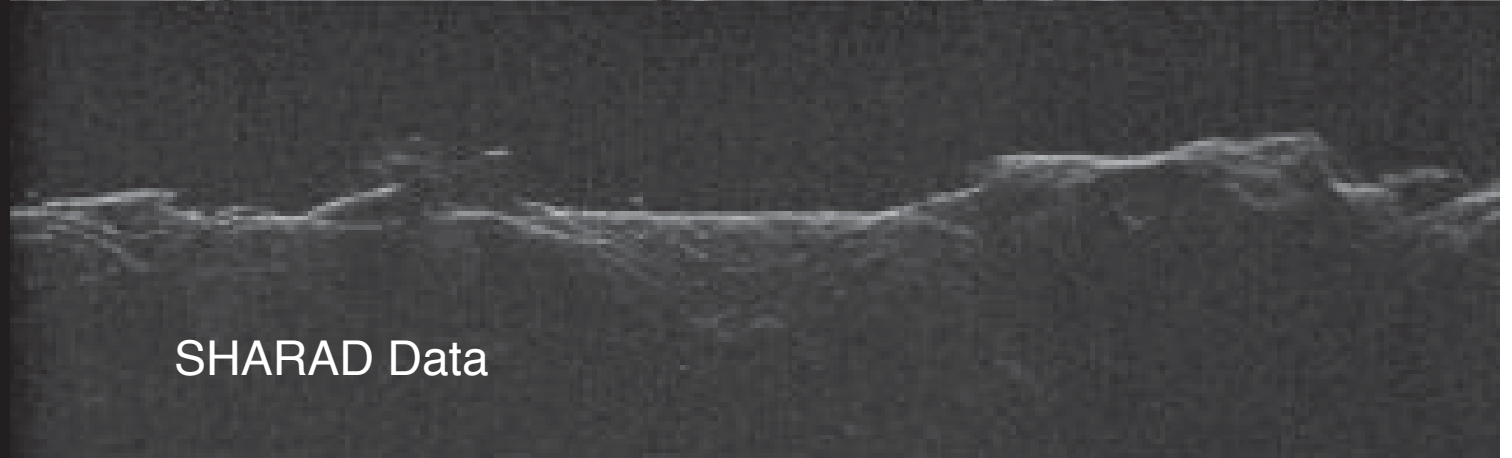
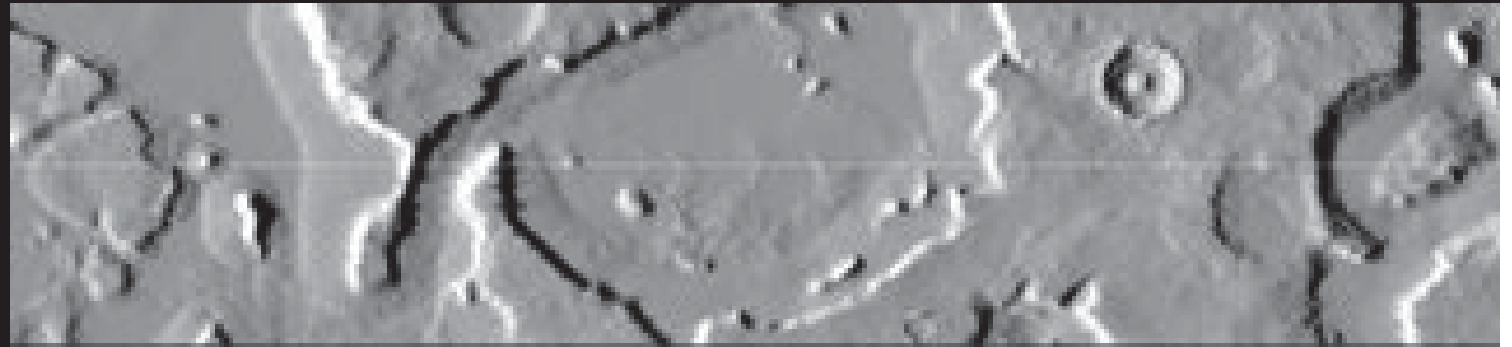
~ 500 m

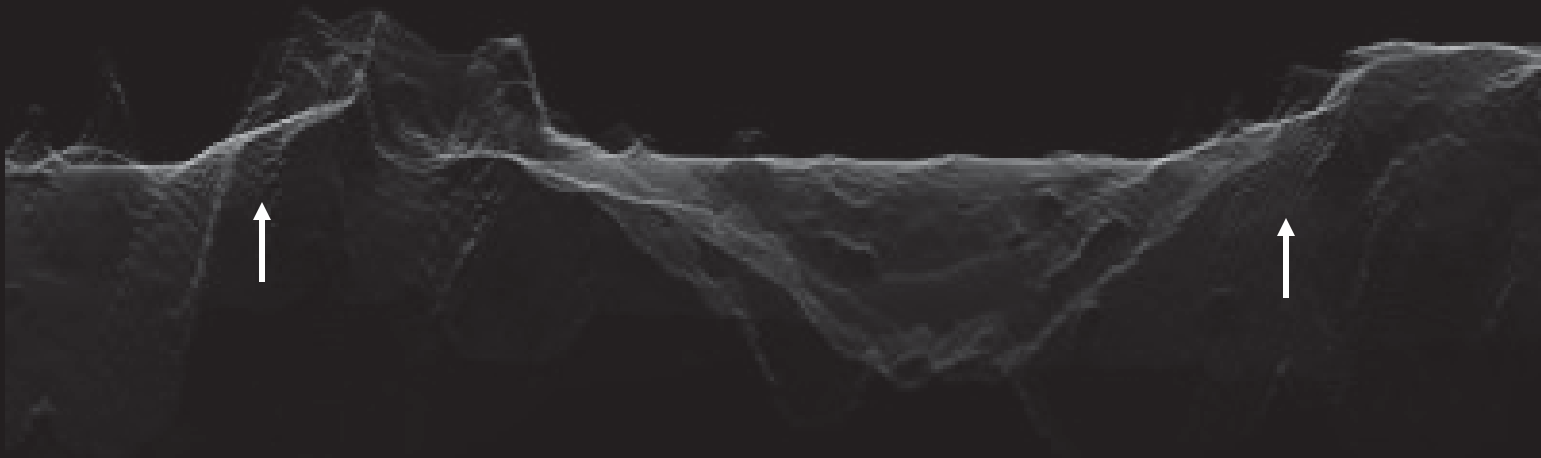
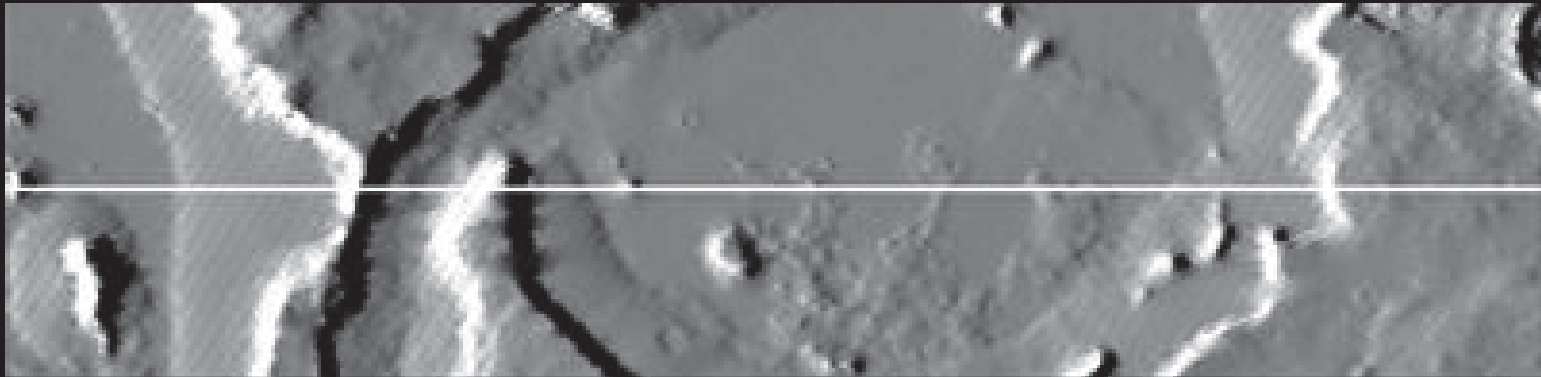
10 km

HRSC

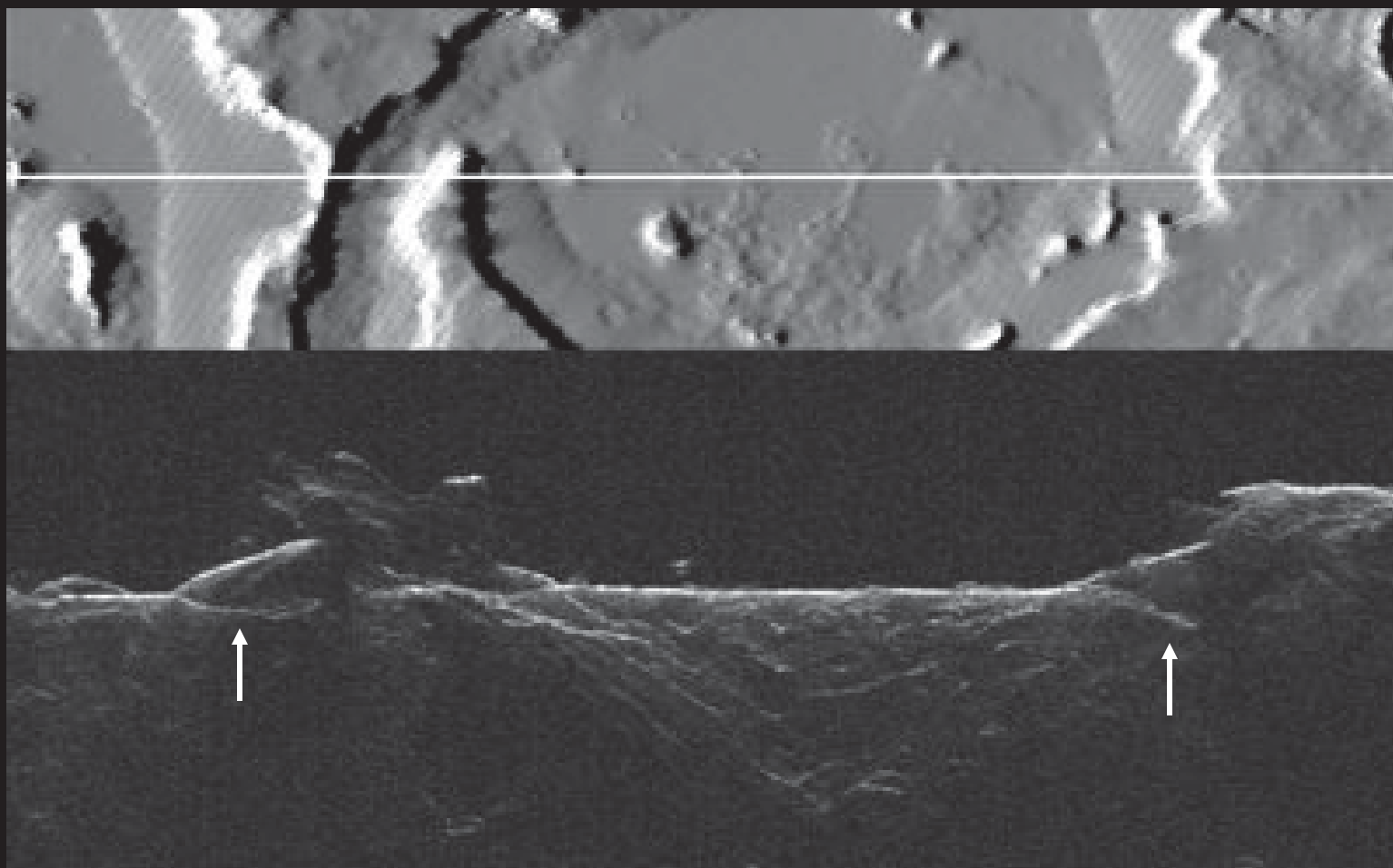


Subsurface, not Clutter





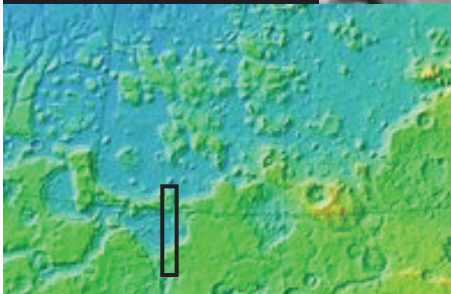
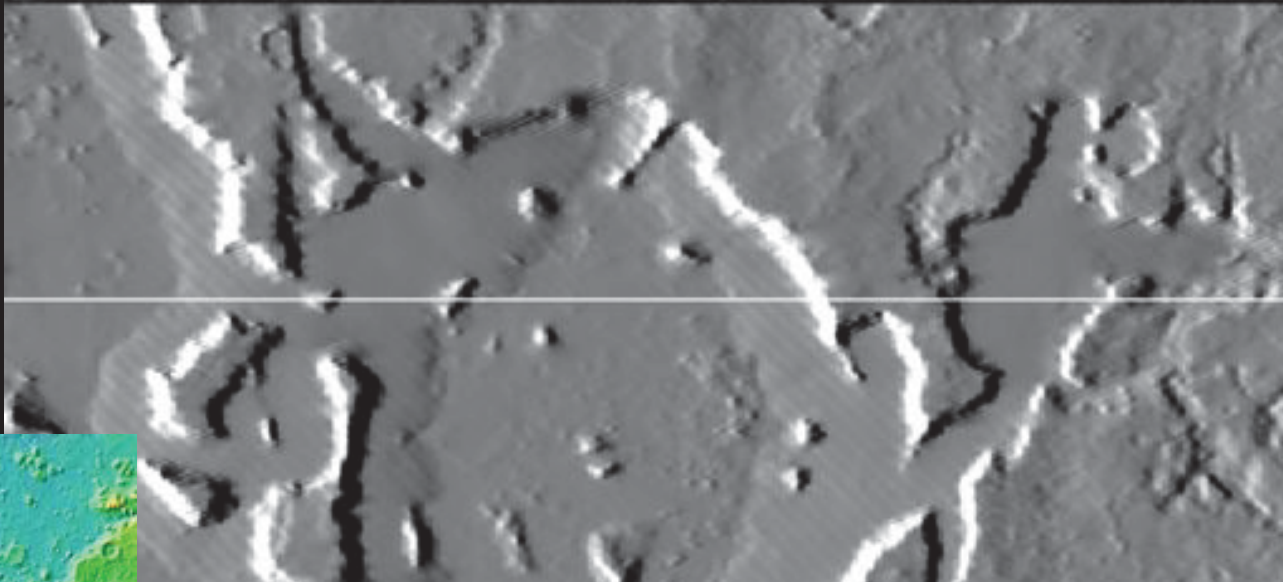
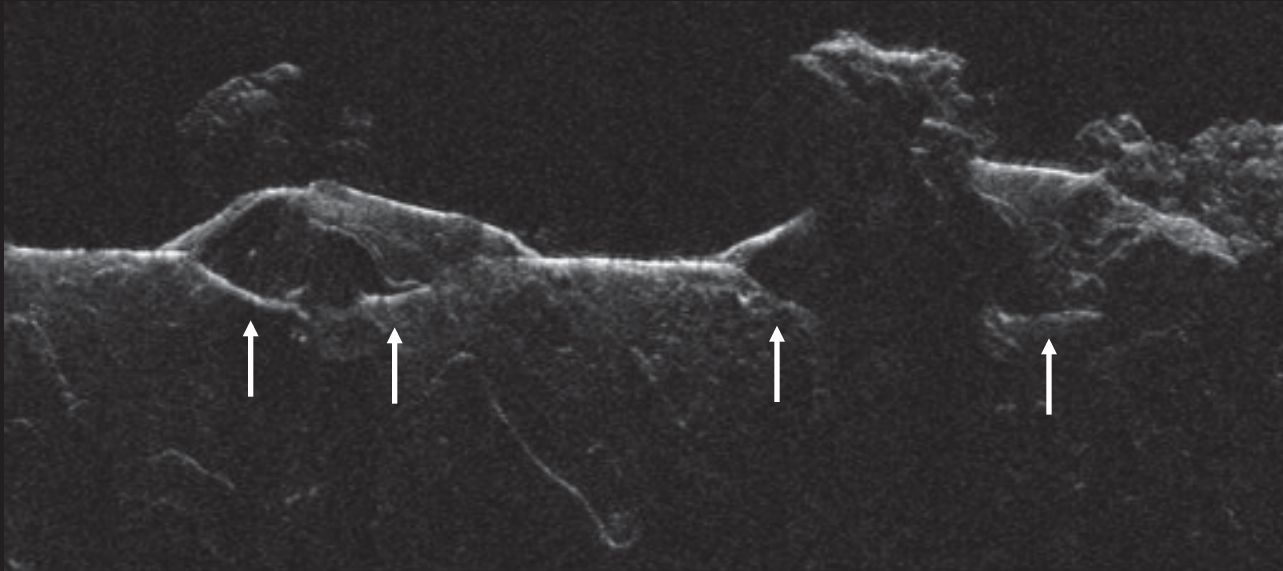
Clutter simulation



SHARAD Data

Converting Time to Depth

Time

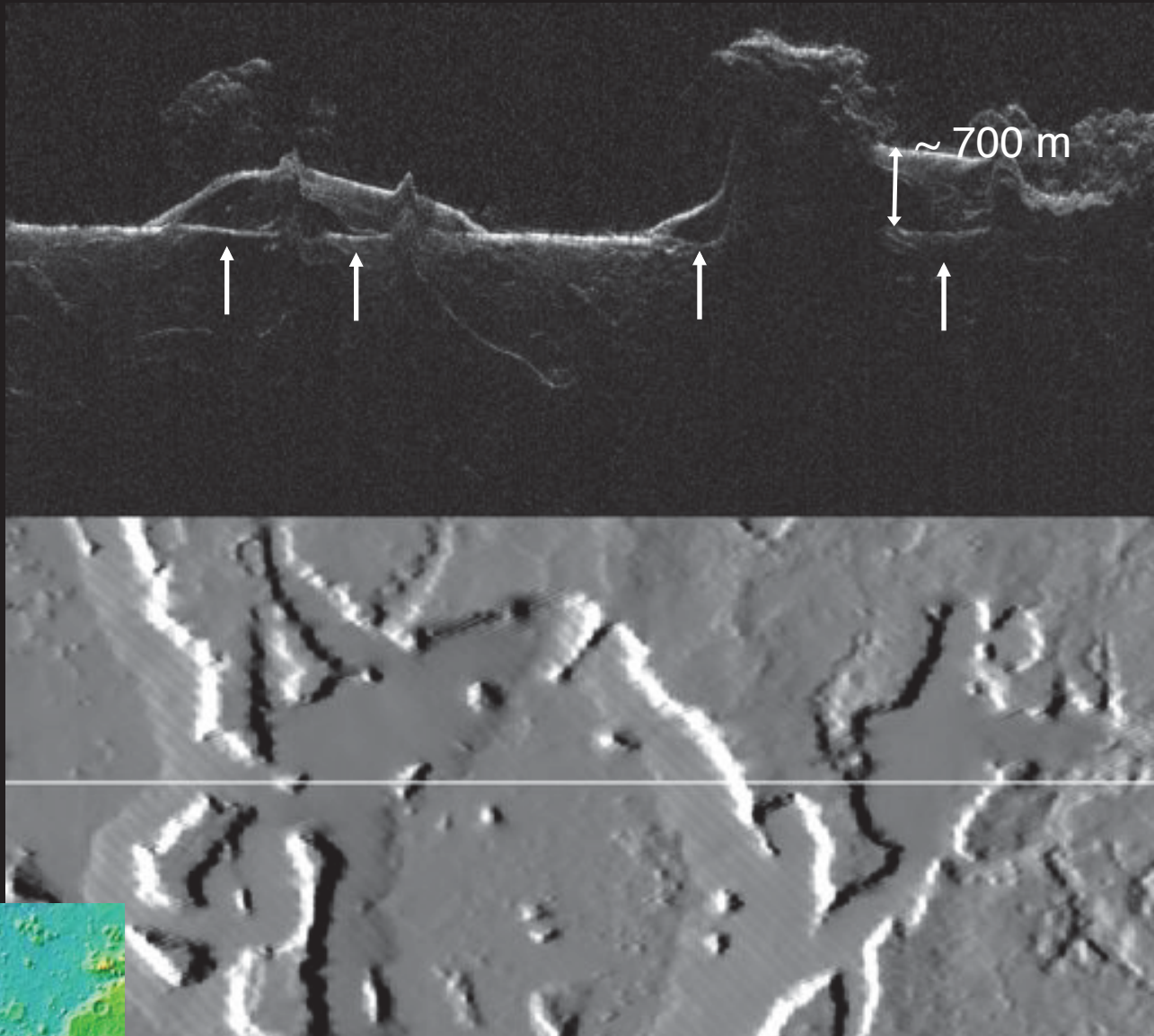


50 km



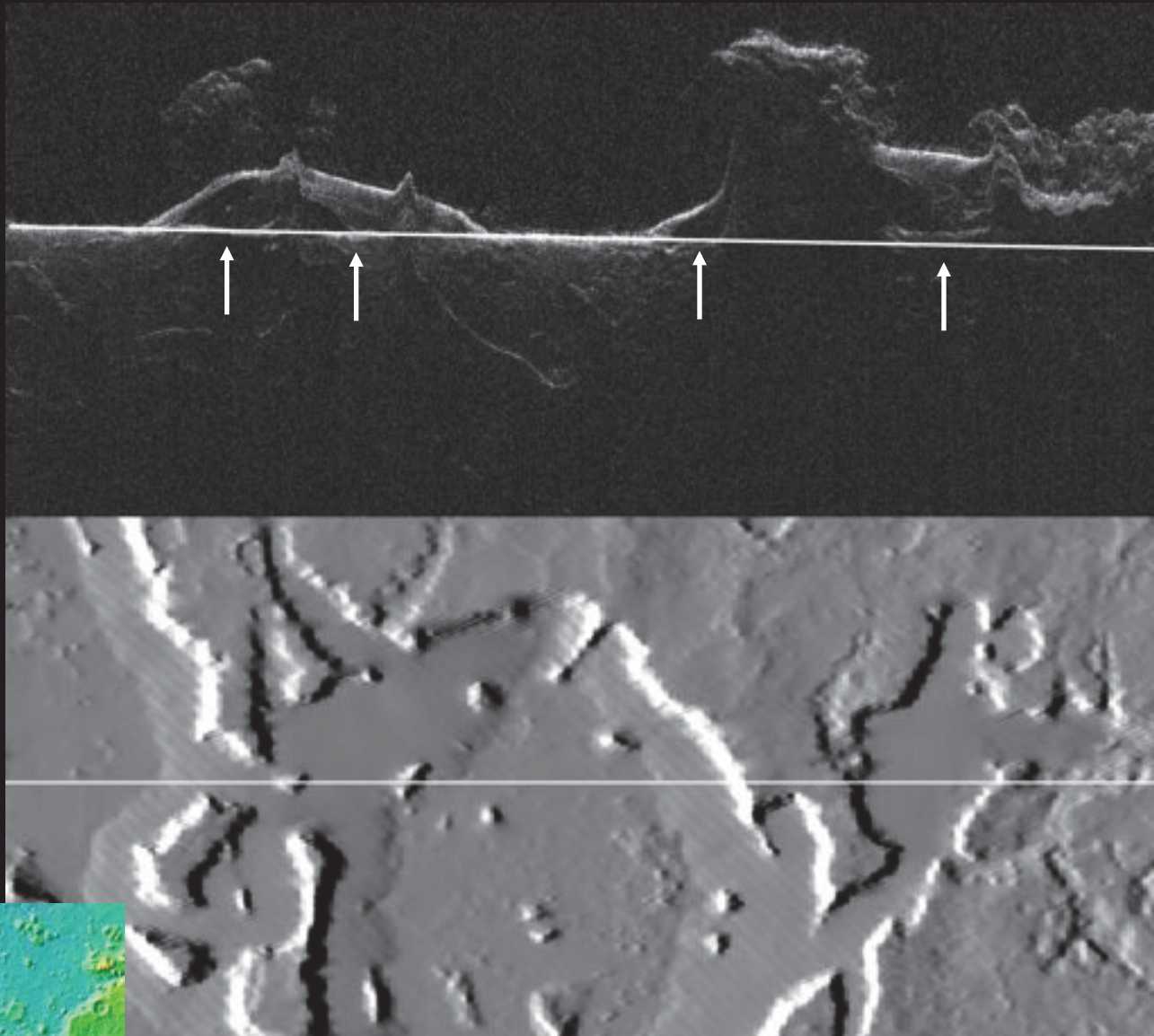
Converting Time to Depth

Depth



Converting Time to Depth

Depth

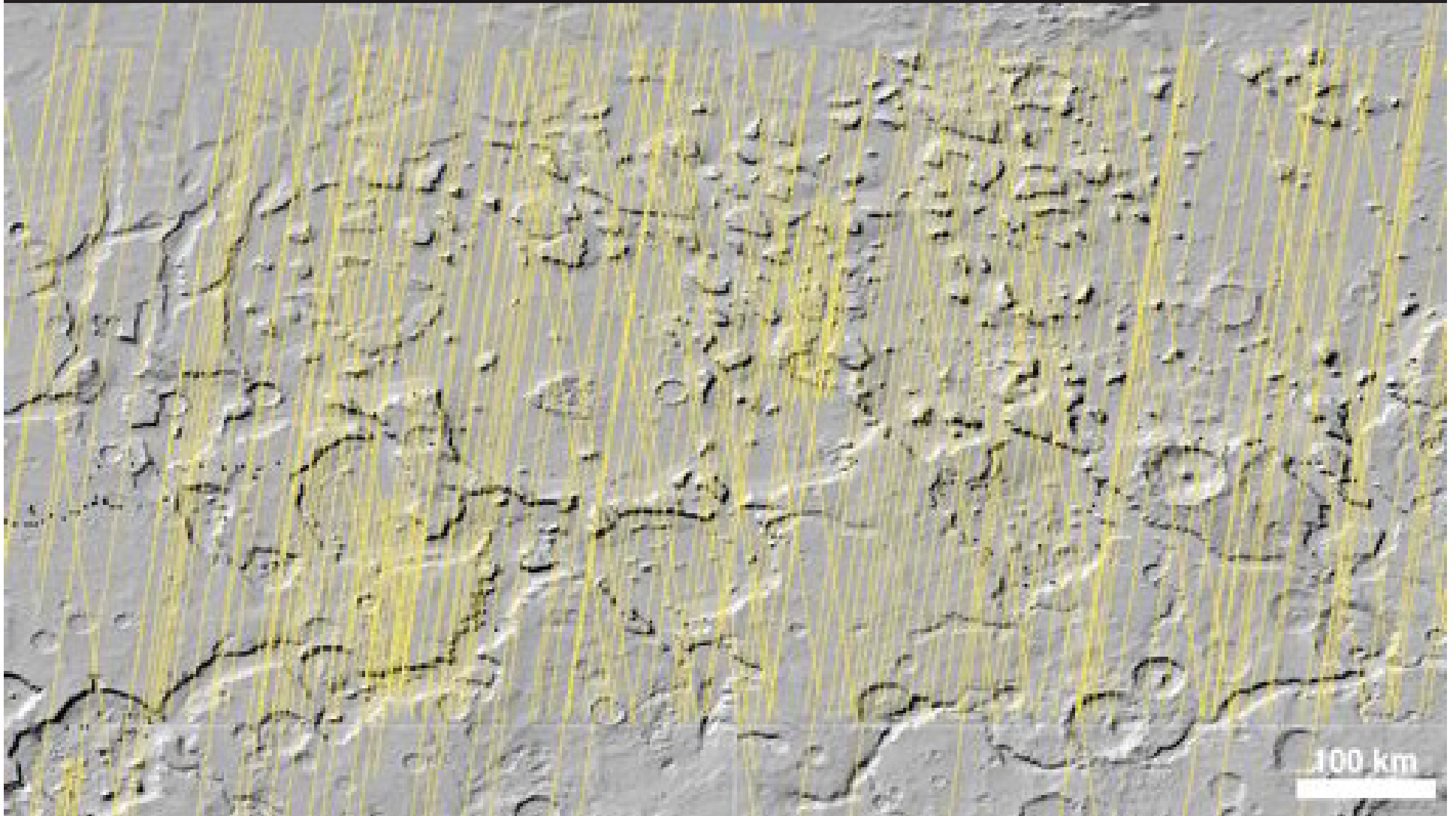


50 km

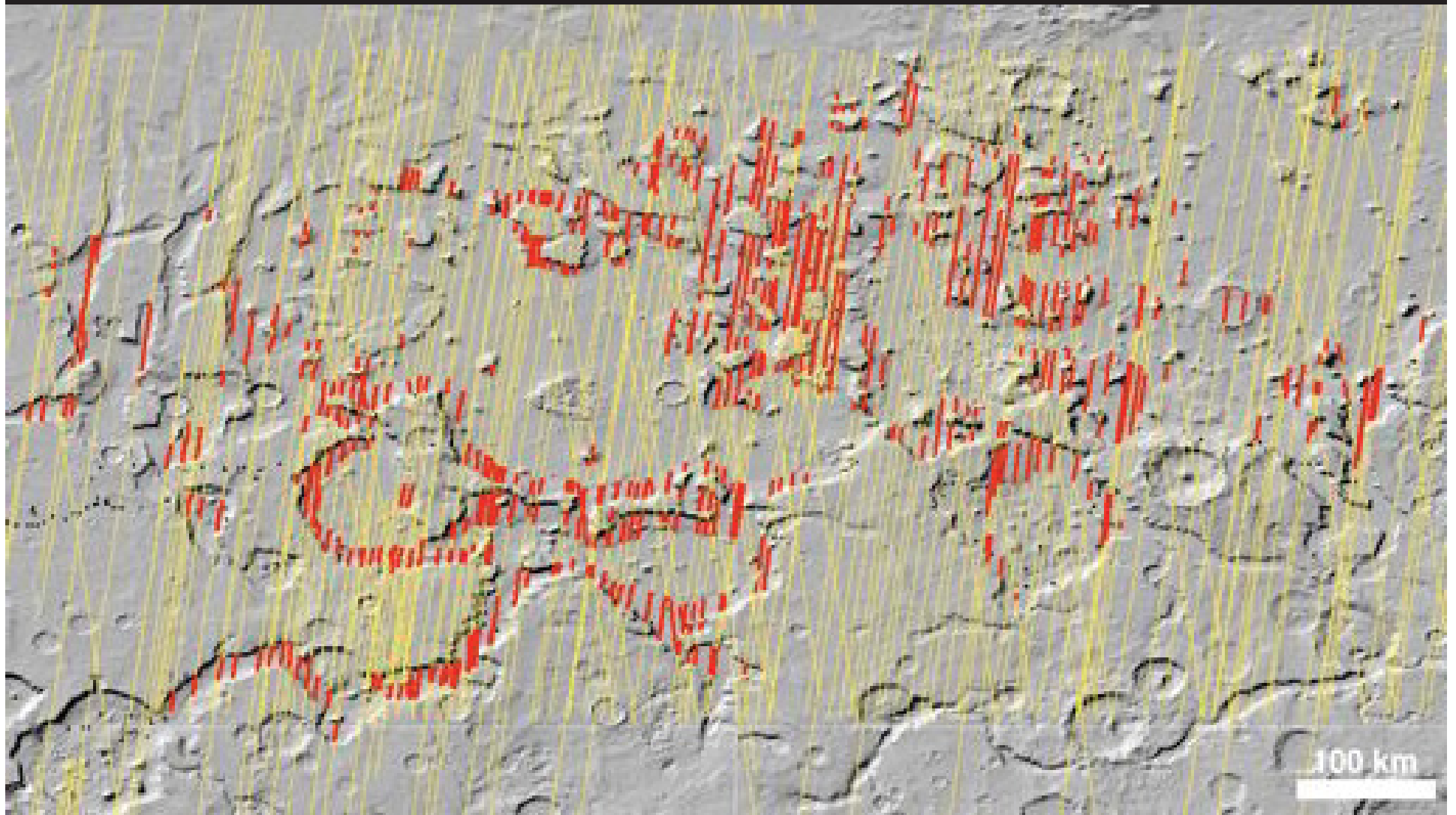
Mapping Criteria

- Compared all potential subsurface detections with clutter simulations. Reflector must be unambiguously distinct from clutter echoes.
- Transformed radargram to time dimension. Reflector must be in a “sensible” position relative to extrapolated valley floor.
- Verified extent/continuity/repeatability of reflector detection by comparing adjacent and overlapping tracks, where available.

SHARAD Coverage – January 2010

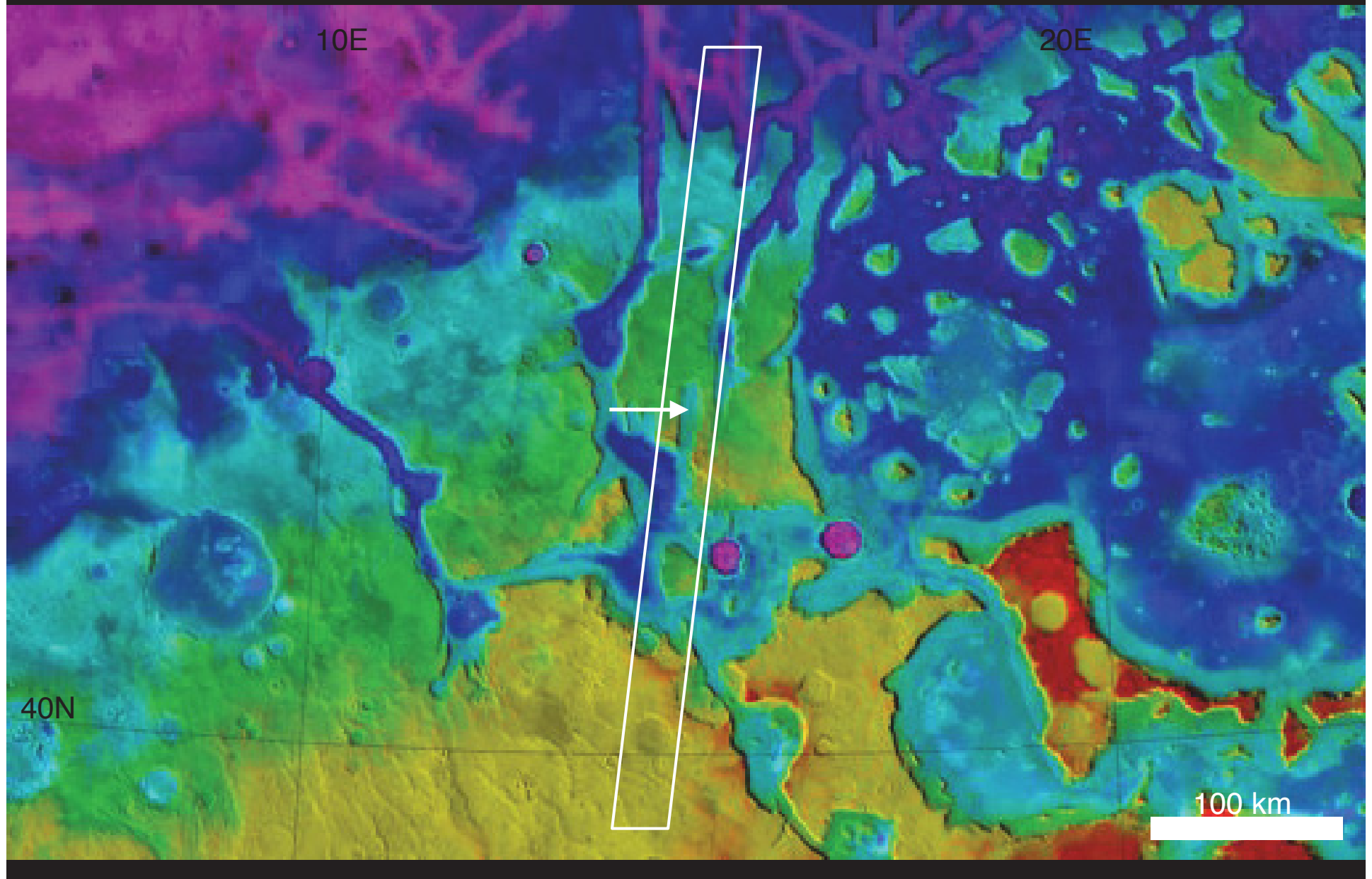


Detected Interfaces

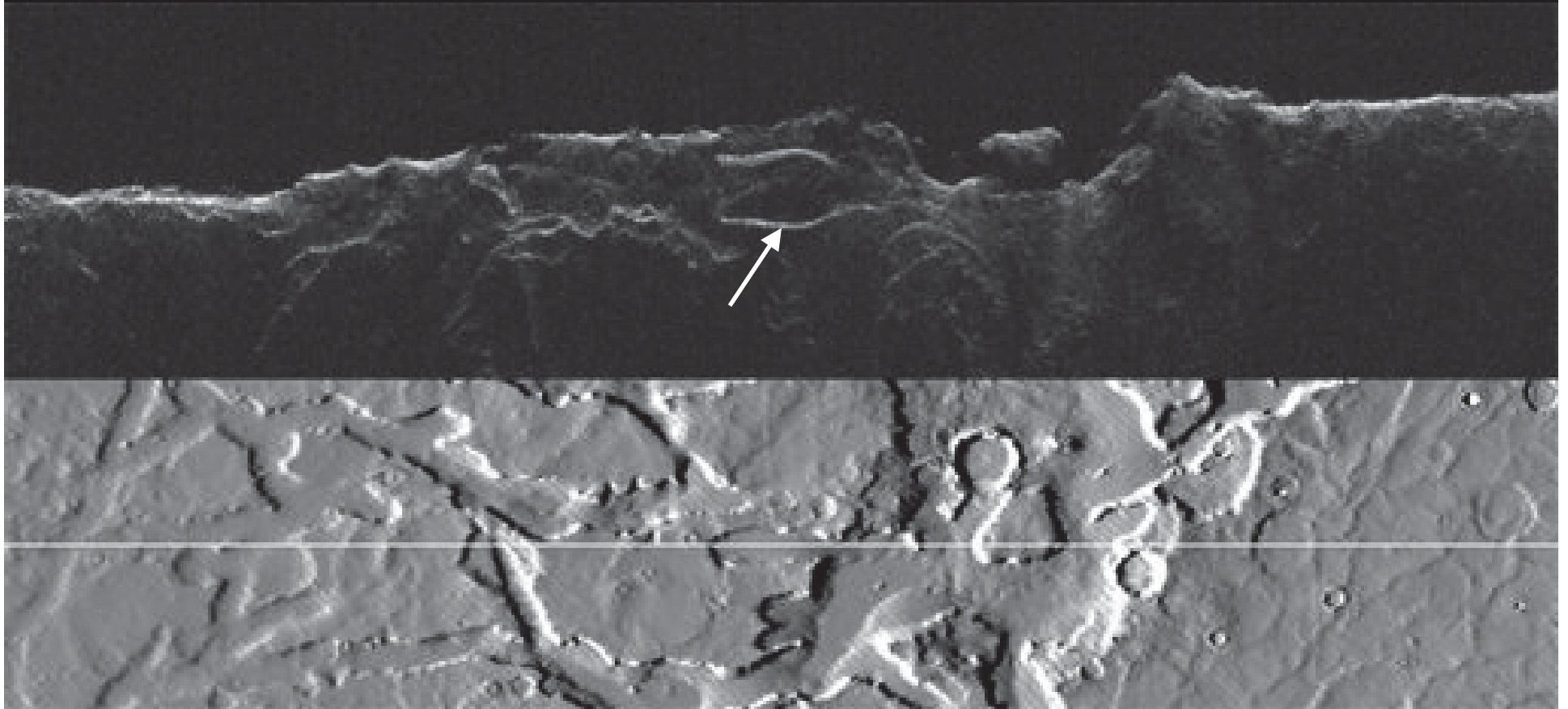


Valley in West Deuteronilus

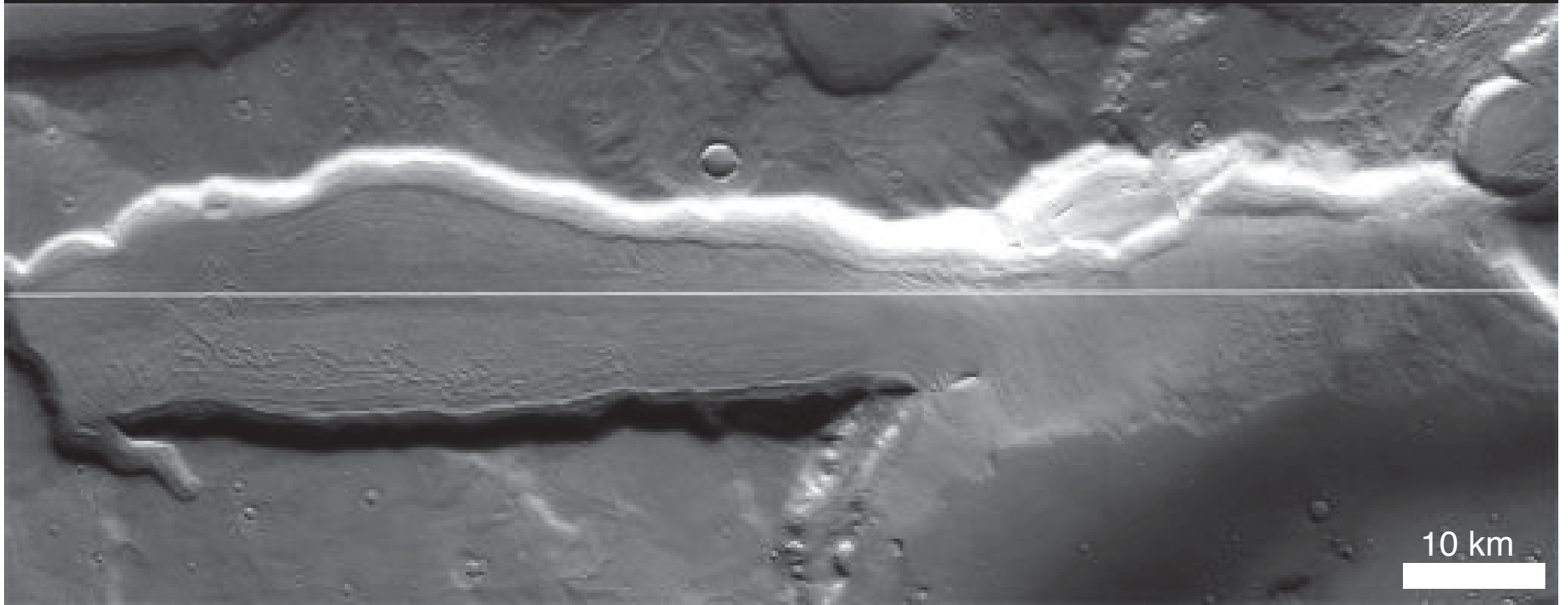
MOLA Elevation on THEMIS Day IR



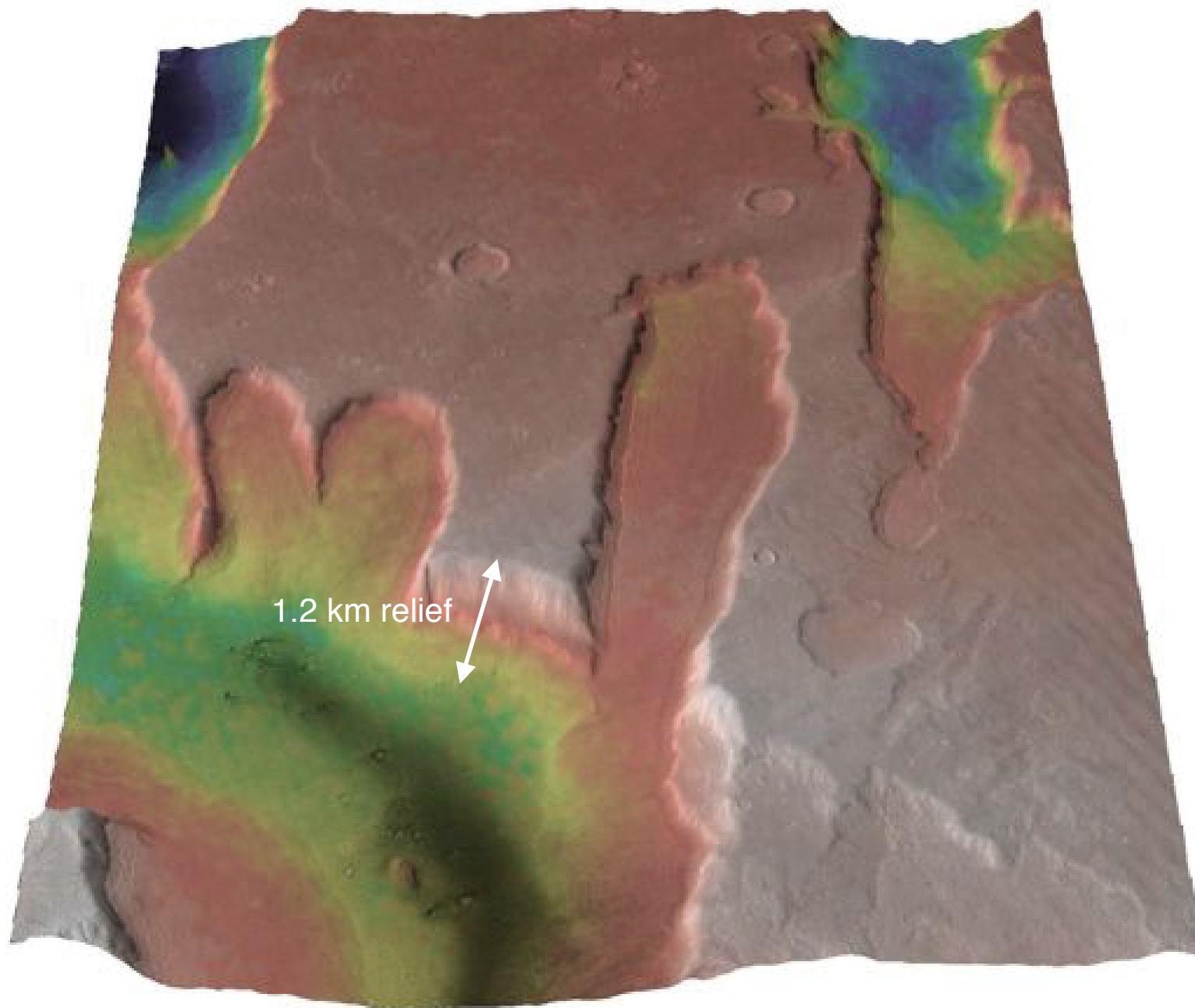
Time



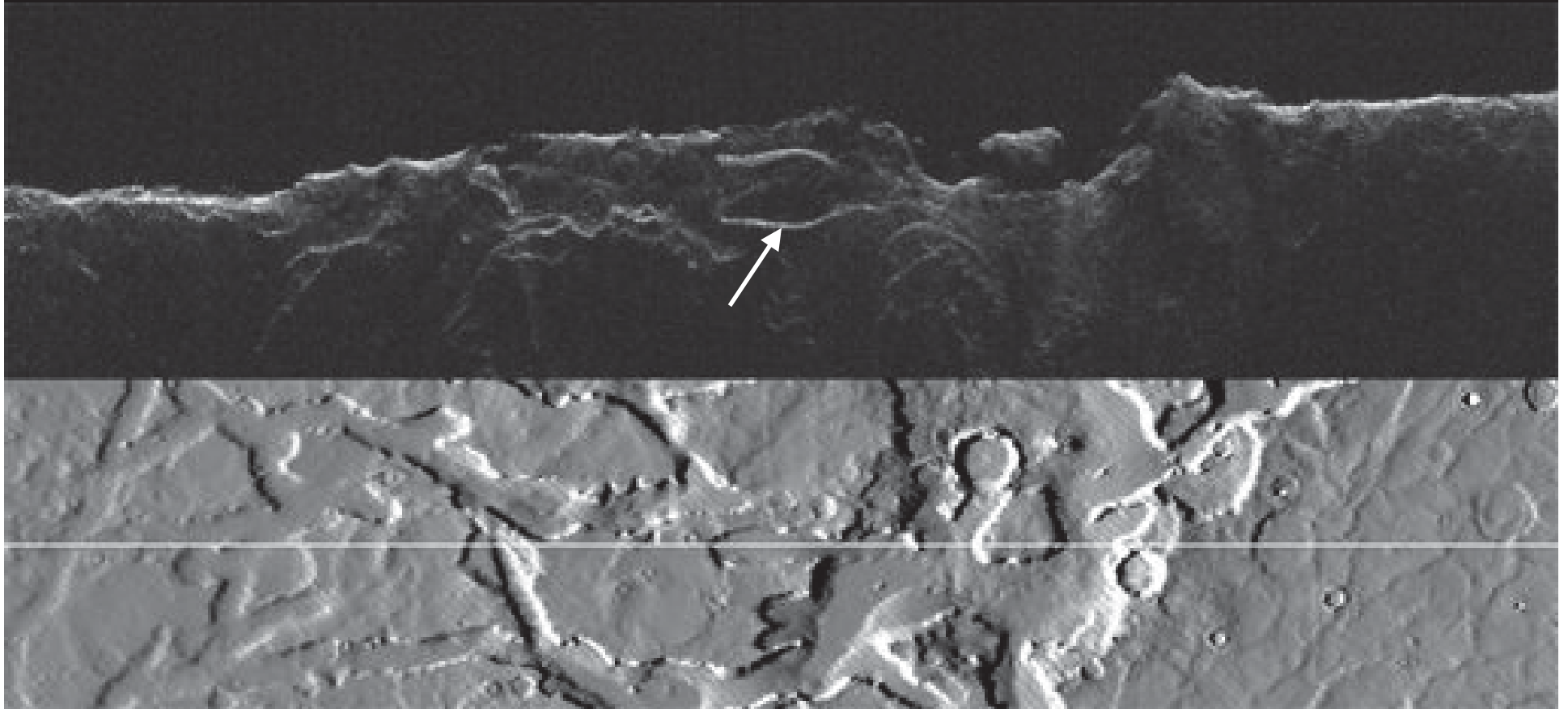
THEMIS VIS



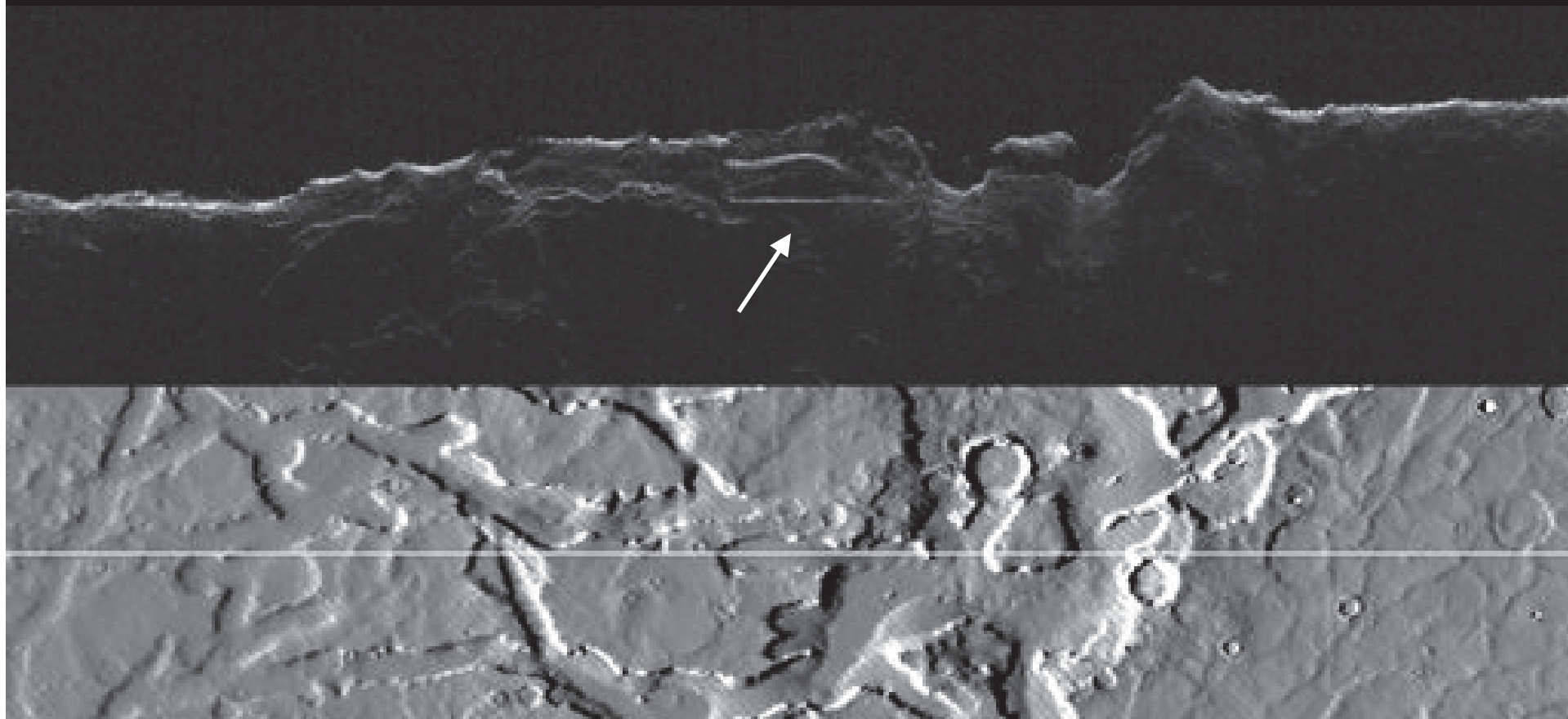
HRSC
Topo



Time

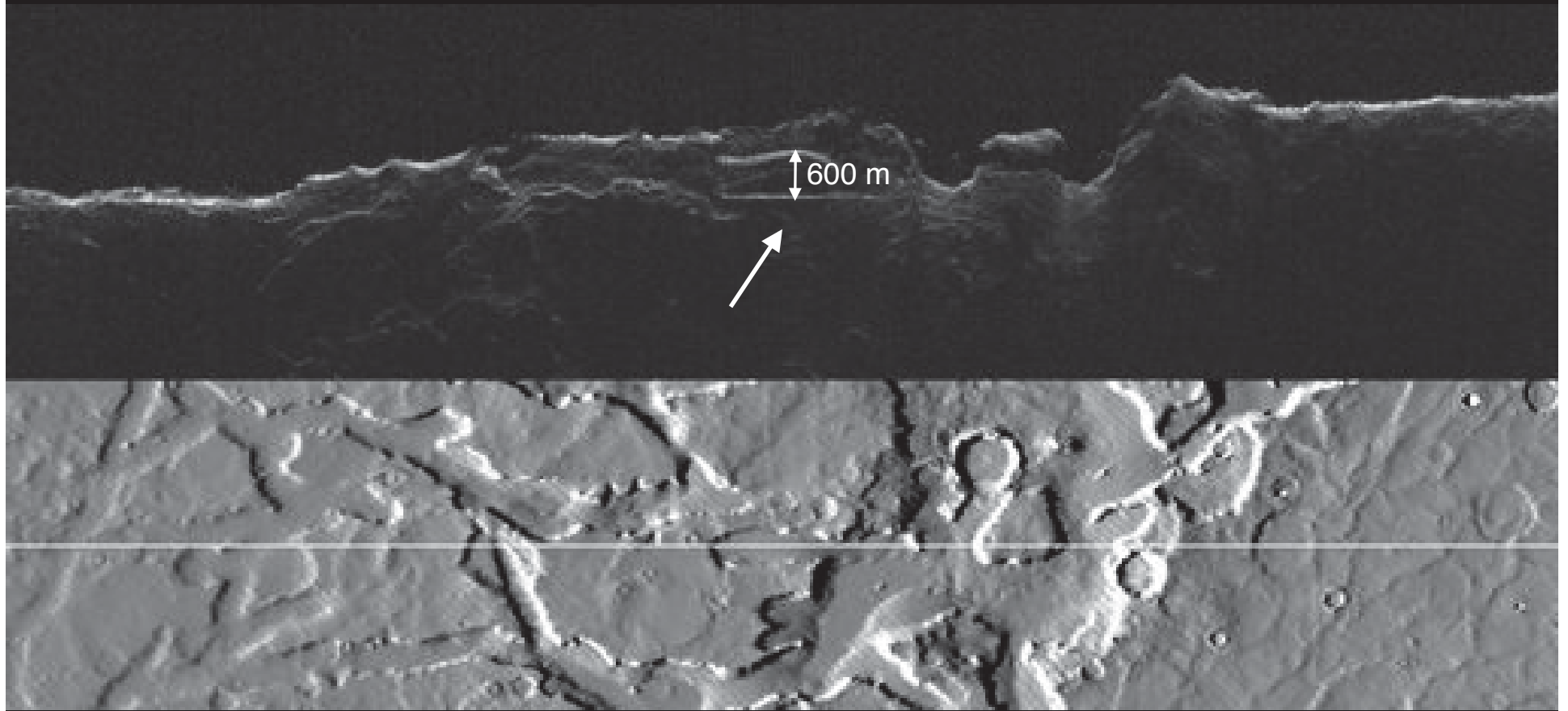


Depth

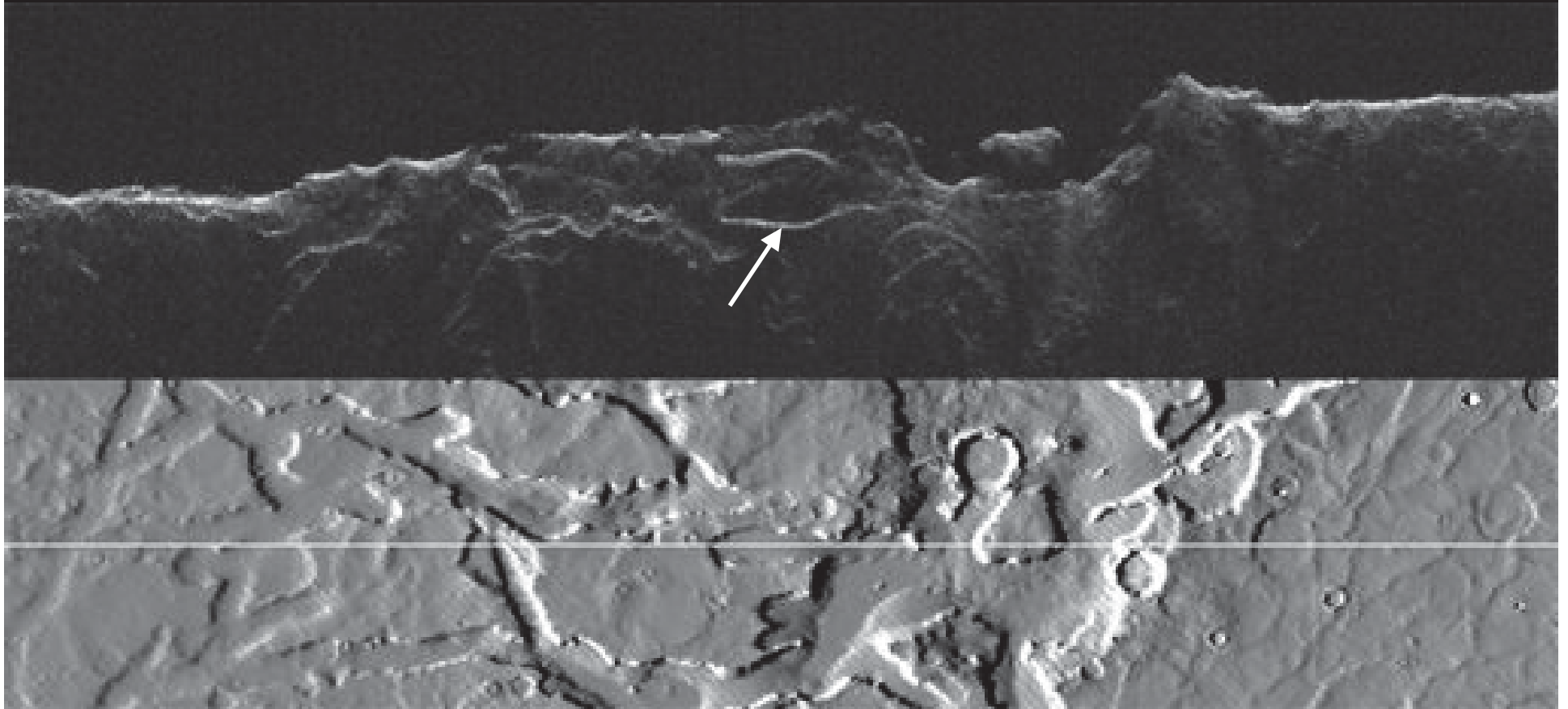


Depth

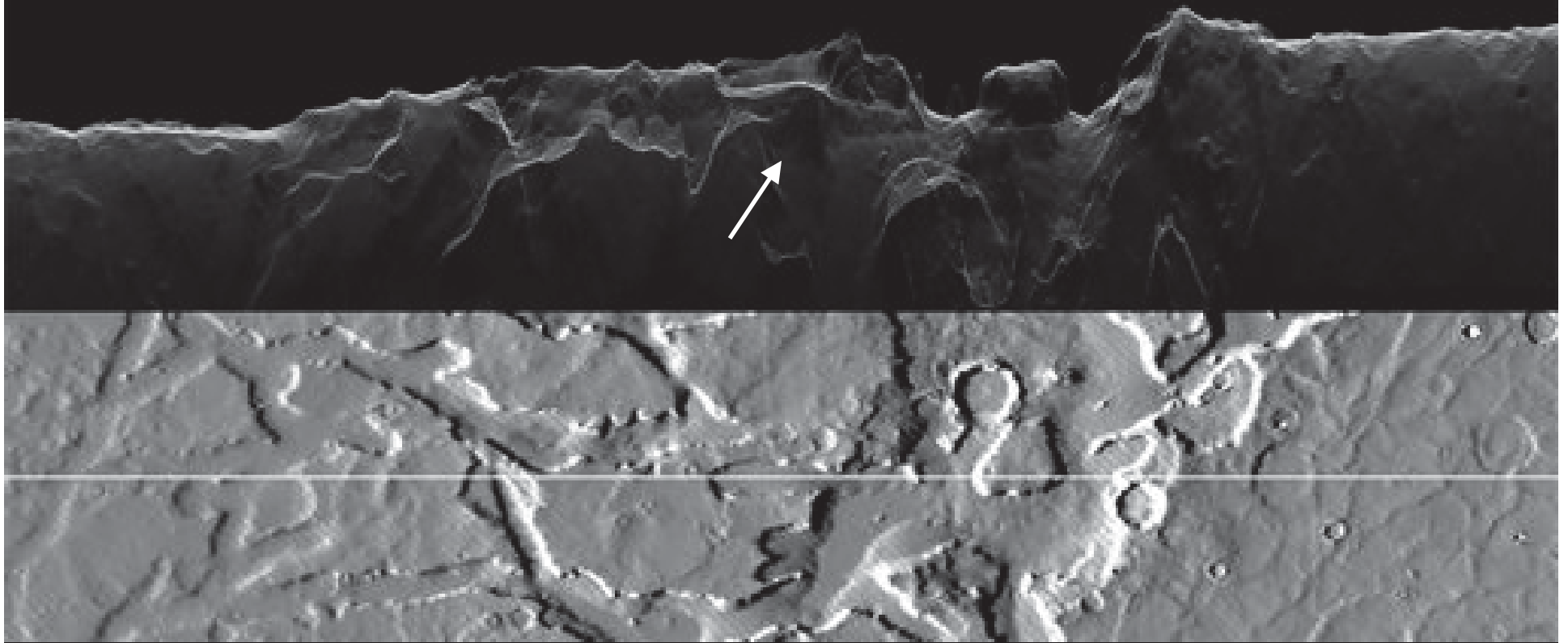
600 m



Time

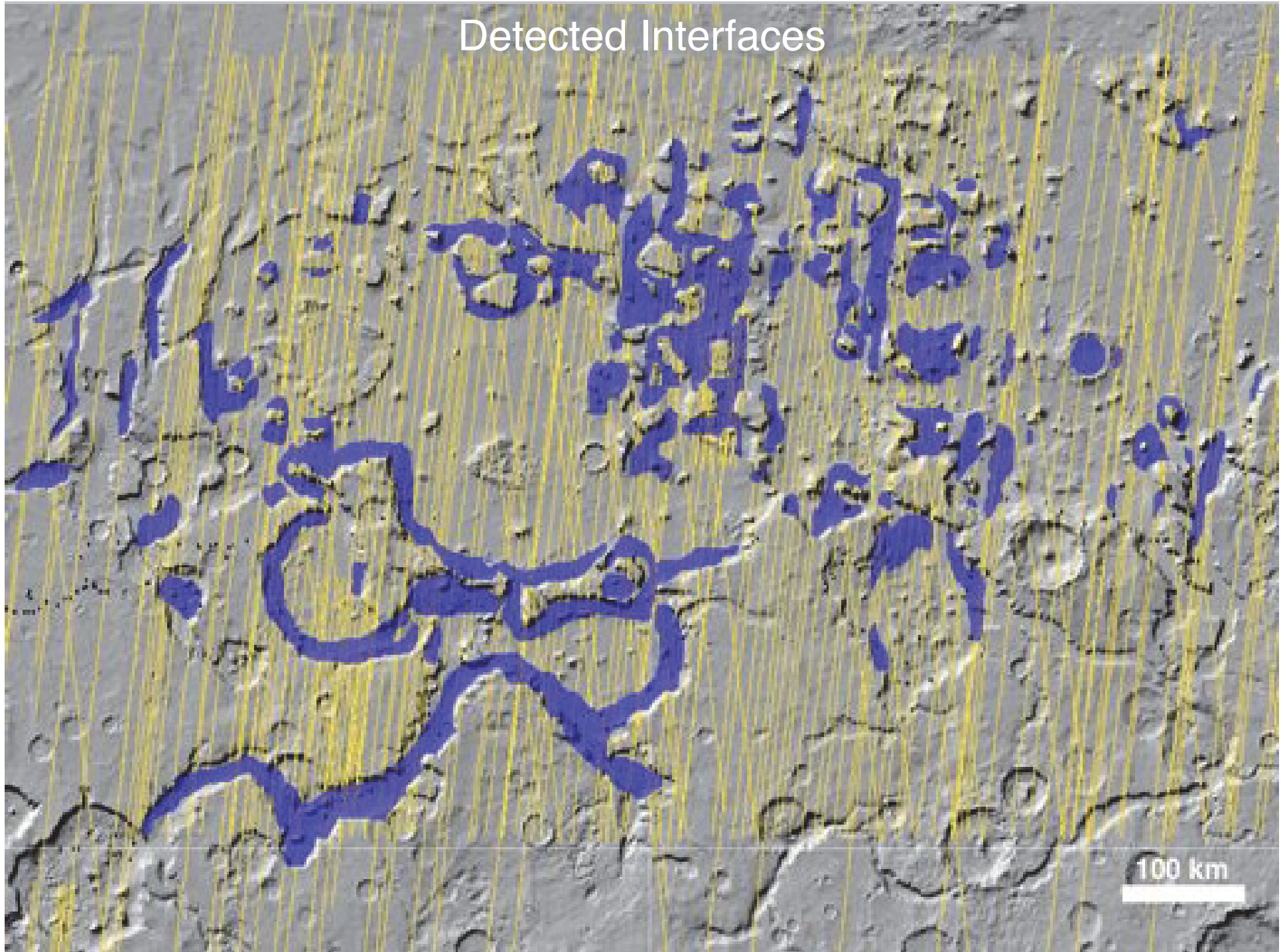


Clutter Simulation



Simulation by UT-Austin

Detected Interfaces



Summary

- SHARAD signals penetrate lobate aprons to ~ 1 km depth.
- Ice is widespread in Deuteronilus Mensae; most “classic” aprons show an ice signature.
- Lobate aprons, lineated valley fill, concentric crater fill all show the same signature.
- Aprons to the east are less amenable to basal reflector detection.
- Surface area of observed ice masses = $21,100 \text{ km}^2$
- Volume (assuming average thickness of 300 m) = 6325 km^3
- ~ 5 cm global equivalent layer (compare to PLD: ~ 20 m)
- Current ice deposits ~ 100 s of MY old are intriguing targets for further exploration.